INSTRUCTION MANUAL

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MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

TYPE 529
MOD 188D

This manual insert describes the features of MOD 188D as installed in the Type 529 Waveform Monitor. The instrument is modified for use with 405/50, 525/60, 625/50, and 819/50 television systems. Added Vertical RESPONSE switch positions, added MAGNIFIER steps and a VARIABLE control, 5 μs/cm and 10 μs/cm sweep rates in addition to line and field rates, and a PAL FRAME SELECTOR permit quick setup for use on any of the four systems without internal adjustments.

CHARACTERISTICS

HORIZONTAL DEFLECTION SYSTEM

Characteristic	Performance Requirement		
	SWEEP RATES		
Line and Field Rate	Sweep Time/CM		
	2 FIELD	2 LINE	1 LINE
405/50	=4 ms	19.75 μs	9.88 μs
525/60	=3.3 ms	12.7 μs	6.35 μs
625/50	=4 ms	12.8 μs	6.4 μs
819/50	=4 ms	9.77 μs	4.88 μs

Accuracy — Accuracy of each calibrated 2 Line, 1 Line, 5 μs/cm, and 10 μs/cm rate (MAG X1) is ±3%.

MAGNIFIER accuracy — Maximum sweep error + magnifier error omitting the first 10% of the sweep.

X5	±3%
X10	±4%
X20	±5%
X25	±5%

MAGNIFIER VARIABLE — Varies magnification +20% and -20%.

DISCRETE LINE SELECTOR — Only displays the line indicated by the front panel marking when used with 525/60 or 625/50 video systems.

VARIABLE LINE SELECTOR — Provides for display of any desired line of the system being used.

PAL FRAME SELECTOR — Provides a means of shifting frames but without positive selection of a specific frame.

FIELD — Provides a means of shifting fields. When viewing a PAL system, operation of the FIELD switch may cause frame shift.

Characteristic	Performance Requirement
STAIRCASE INPUT	
Input Resistance	Adjustable over a range of 220k to 1.1M or greater.
Offset Range	Sufficient to provide normal horizontal alignment without readjustment of Horizontal POSITION control for a staircase generator of typical design.

VERTICAL DEFLECTION SYSTEM

Characteristic	Performance Requirement
	RESPONSE SWITCH
FLAT	Unchanged
IRE	Same as IEEE and unchanged
LOW PASS	Unchanged.
1.10 MHz BANDPASS	Sensitivity is twice that of the 3.58 MHz position. 1.10 MHz center frequency; 10%, or less, down at 0.9 and 1.3 MHz; at least 18 dB down at 0.2 and 2 MHz.
3.58 MHz BANDPASS	Unchanged
4.43 MHz BANDPASS	Sensitivity is twice that of the 3.58 MHz position. 4.43 MHz center frequency; 15% to 35% down at 3.93 MHz and 5.13 MHz; down 20 dB or more below 0.2 MHz.
	INPUT SELECTOR SWITCH
A-DC COUPLED	DC coupled. DC RESTORER should be turned off when this position is used.
	CALIBRATOR
Accuracy	
.700 F.S.	Adjustable to .700 V.
.714 F.S.	Negligible error.
FULL SCALE	Within ±1% of 1V.

OPERATING INSTRUCTIONS

The four position Vertical RESPONSE switch is replaced with a six position switch. Three BANDPASS positions are provided in place of the HIGH PASS position. Center frequencies for the positions are 1.10 MHz, 3.58 MHz (same as old HIGH PASS), and 4.43 MHz.

A position is added to the Vertical INPUT switch to provide DC-coupling of the A VIDEO INPUT. Normal AC coupling is provided for the four standard positions.

An added position of the CALIBRATOR switch provides .700 F.S. for verification of blanking level in CCIR systems.

A four-position LINE AND FIELD RATE selector switch is added to the front panel, concentric with the DISPLAY switch. This control selects the appropriate timing circuit for the 405/50, 525/60, 625/50 or 819/50 system and lights the corresponding front-panel indicator.

Two positions are added to the DISPLAY switch to provide the following:

2 FIELD - one frame (of system selected by LINE AND FIELD RATE switch).
2 LINE - two complete horizontal lines in 10 cm.
1 LINE - one complete horizontal line in 10 cm.
10μS/CM - time/cm (not related to LINE AND FIELD RATE).
5μS/CM - time/cm (not related to LINE AND FIELD RATE).

1 LINE
10μS/CM LINE SELECTOR
5μS/CM

The LINE SELECTOR switch provides positive selection of lines 16 through 21 appearing at the start of the display when used with 525/60 or 625/50 systems. The VARIABLE LINE SELECTOR provides for display of any desired line of the system for which the LINE AND FIELD RATE switch is set.

Two calibrated positions and a VARIABLE are added to the Horizontal MAGNIFIER providing X1, X5, X10, X20, and X25 magnification, variable to +20% and -20% of switch setting. The VARIABLE is equipped with an indicator lamp which lights when the control is in the CALIB position (fully clockwise). Two CCIR graticules are provided; one for use in sin and K factor measurements (331-0185-00) and one scribed off in 0-100 units with a 30 unit blanking level (331-0184-00). For sin graticule application, in the 1 LINE position of the DISPLAY switch, the X20 and X25 positions of the MAGNIFIER are color-coded green and blue to correspond with the 525/60 and 625/50 systems.

The positions of the FIELD switch are marked EVEN and ODD (color-coded blue to correspond with 625/50) in addition to the standard markings, ONE and TWO.

A three-position PAL FRAME SELECTOR switch (color-coded blue to correspond with 625/50) is added to provide a means of displaying fields or lines from only one frame of the two-frame cycle of the PAL color system, or from all frames when the switch is set to NORM. Used in conjuction with the FIELD switch, the PAL FRAME SELECTOR permits viewing either field of either frame of the PAL system by switching to one of the two extreme (top or bottom) positions.

The modified staircase input circuit allows selection of 3-step(RGB) or 4-step(YRGB) displays. An internal selector switch, SW510, provides appropriate 1/3 screen or 1/4 screen sweeps when the staircase input relay, K501, is energized and the DISPLAY switch is in the 2 FIELD position.

Input resistance and horizontal position offset adjustments are provided to match the characteristics of various staircase generators. The resistance at pin C of J501 is adjustable over a range of 220k to 1.1M. The offset range is sufficient to provide normal horizontal alignment of both staircase and conventional waveform displays without readjustment of the Horizontal POSITION control.

The power transformer is changed to a multi-tap primary type providing optional wiring for nominal line voltages of 105, 110, 115, 120, 210, 220, 230, and 240 volts. The rear panel tag is used to indicate the line voltage for which the transformer is wired.

CALIBRATION

The following outline and procedure should be used in conjunction with the manual procedure to calibrate this modified instrument.

Additional Equipment Required:

Composite Video Generator - Programmable for 405/50, 525/60, 625/50, and 819/50 systems.

Additional Preliminary Control Settings:

LINE AND FIELD RATE	525/60
MAGNIFIER VARIABLE	CALIB
PAL FRAME SELECTOR	NORM

1. Adjust -25 VOLTS/AMPL (R620)

Refer to the manual procedure.

2. Check Low-Voltage Power-Supply Regulation and Ripple

Refer to the manual procedure.

3. Adjust HIGH VOLTAGE (R814)

Refer to the manual procedure.

4. Check High Voltage Regulation

Refer to the manual procedure.

5. Adjust ASTIG (R864)

Refer to the manual procedure.

6. Adjust TRACE ROTATION (CRT BEAM ROTATOR, R655)

Refer to the manual procedure.

7. Adjust UNBLANKING PLATE BIAS (R855)

Refer to the manual procedure.

8. Adjust DC BAL (R115)

Refer to the manual procedure.

9. Adjust VAR DC BAL (R130)

Refer to the manual procedure.

10. Adjust VERT GAIN (R169)

Refer to the manual procedure.

11. Adjust Vertical 0.2 VOLTS FULL SCALE GAIN (R119)

Refer to the manual procedure.

12. Check Vertical 0.5 VOLTS FULL SCALE Gain Accuracy

Refer to the manual procedure.

13. Adjust TRIG MULTI BIAS (R325)

Set up the triggering using the standard procedure, with the LINE AND FIELD RATE switch in the 525/60 position. (Use 525/60 composite video.) After setting the Trigger Multi Bias (R325), check the triggering in the other positions of the LINE AND FIELD RATE switch. (Apply appropriate composite video.) A slight readjustment may be necessary for proper triggering at all four rates. Return LINE AND FIELD RATE to 525/60.

TYPE 529, MOD 188D

14. Check External Sync

Refer to the manual procedure.

15. Check DC RESTORER switch.

Refer to the manual procedure.

16. Adjust HORIZ GAIN (R568)

With the LINE AND FIELD RATE switch in the 525/60 position and the DISPLAY switch in 2 FIELD, apply 525/60 composite video. Adjust the HORIZ GAIN for a sweep length of 10.2 cm ±3%. Check the gain in the other positions of the LINE AND FIELD RATE switch for a minimum sweep length of 9.8 cm. Apply the appropriate composite video.

16A. Adjust Line Rate Sweep Length (R494)

Set the DISPLAY switch to 2 LINE. The sweep length will increase in the Line Mode of operation. Adjust R494 for approximately 12 cm (spec is 10.5 cm minimum).

17. Adjust Miller Timing Capacitors (C481A, B, C, D)

(a) Apply 405/50 video, switch LINE AND FIELD RATE to 405/50, and set DISPLAY switch to 1 LINE. The sweep frequency is 10.125 Hz with 98.75 μs between horizontal sync pulses. Adjust Miller Timing Capacitor, C481A, for exactly 10 cm between horizontal sync pulses. This is 98.75 μs in 10 cm. Change DISPLAY switch to 2 LINE and check for 10 cm between the first and third pulses (197.5 μs/10 cm), ±3%.

(b) Apply 525/60 video, switch LINE AND FIELD RATE to 525/60, and set DISPLAY switch to 1 LINE. The sweep frequency is 15,750 Hz with 63.5 μs between horizontal sync pulses. Adjust Miller Timing Capacitor, C481B, for exactly 10 cm between horizontal sync pulses. This is 63.5 μs in 10 cm. Change DISPLAY switch to 2 LINE and check for 10 cm between the first and third pulses (127 μs/10 cm), ±3%.

(c) Apply 625/50 video, switch LINE AND FIELD RATE to 625/50, and set DISPLAY switch to 1 LINE. The sweep frequency is 15,625 Hz with 64 μs between horizontal sync pulses. Adjust Miller Timing Capacitor, C481C, for exactly 10 cm between horizontal sync pulses. This is 64 μs in 10 cm. Change DISPLAY switch to 2 LINE and check for 10 cm between the first and third pulses (128 μs/10 cm), ±3%.

(d) Apply 819/50 video, switch LINE AND FIELD RATE to 819/50, and set DISPLAY switch to 1 LINE. The sweep frequency is 20,475 Hz with 48.93 μs between horizontal sync pulses. Adjust Miller Timing Capacitor, C481D, for exactly 10 cm between horizontal sync pulses. This is 48.93 μs in 10 cm. Change DISPLAY switch to 2 LINE and check for 10 cm between the first and third pulses (97.86 μs/10 cm), ±3%.

18A. Check X1 Sweep Timing

Connect the time-mark generator output to either A or B VIDEO INPUT. Connect the time-mark generator trigger output to the test oscilloscope trigger input. Connect the test oscilloscope +Gate output to the EXT NEG SYNC INPUT. Set the time-mark generator to 1 μs and 10 μs markers, and 10 μs triggers. Set the SYNC switch to EXT and the MAGNIFIER to X1.

(a) Switch LINE AND FIELD RATE to 405/50, and set DISPLAY switch to 1 LINE. Check for 9 ea 10 μs markers (not counting the first marker) plus 8 3/4 ea 1μs markers in 10 cm (9.875 μs/cm), ±3%. Change the DISPLAY switch to 2 LINE and check for 19 ea. 10 μs markers plus 7 1/2 ea 1 μs markers in 10 cm (19.75 μs/cm), ±3%.

(b) Switch LINE AND FIELD RATE to 525/60, and set DISPLAY switch to 1 LINE. Check for 6 ea 10 μs markers (not counting the first marker) plus 3 1/2 ea 1 μs markers in 10 cm (6.35 μs/cm), ±3%. Change the DISPLAY switch to 2 LINE and check for 12 ea 10 μs markers plus 7 ea 1 μs markers in 10 cm (12.7 μs/cm), ±3%.

(c) Switch LINE AND FIELD RATE to 625/50, and set DISPLAY switch to 1 LINE. Check for 6 ea 10 μs markers (not counting the first marker) plus 4 ea 1 μs markers in 10 cm (6.4 μs/cm), ±3%. Change the DISPLAY switch to 2 LINE and check for 12 ea 10 μs markers plus 8 ea 1 μs markers in 10 cm (12.8 μs/cm), ±3%.

(d) Switch LINE AND FIELD RATE to 819/50, and set DISPLAY switch to 1 LINE. Check for 4 ea 10 μs markers (not counting the first marker) plus 9 ea 1 μs markers in 10 cm (4.893 μs/cm), ±3%. Change the DISPLAY switch to 2 LINE and check for 9 ea 10 μs markers plus 8 ea 1 μs markers in 10 cm (9.876 μs/cm), ±3%.

18B. Adjust Miller Timing Capacitor (C481)

Set the DISPLAY switch to 5 μS/CM and adjust C481 for 5 ea 10 μs markers (not counting the first marker) in 10 cm (5 μs/cm). Change the DISPLAY switch to 10 μS/CM and check for 10 ea 10 μs markers, ±3%.

18C. Check X5 Sweep Timing

Connect the test equipment as described in the previous step. Change the MAGNIFIER to X5 and apply 1 μs time markers. Set DISPLAY to 5 μS/CM and check for 10 ea 1 μs markers in 10 cm, ±3%. Change DISPLAY to 10 μS/CM and check for 20 ea, 1 μs markers in 10 cm, ±3%.

18D. Check X10 Sweep Timing

Change the MAGNIFIER to X10 and apply 0.5 μs markers. Set DISPLAY to 5 μS/CM and check for 10 ea 0.5 μs markers in 10 cm, ±3%. Change DISPLAY to 10 μS/CM and check for 20 ea 0.5 μs markers in 10 cm, ±3%.

18E. Adjust X20 Sweep Timing

Change the MAGNIFIER to X20, DISPLAY to 10μS/CM, and apply 0.5 μs markers. Preset C527 to midrange and adjust R528 for 10 ea 0.5 μs markers in 10 cm. Change DISPLAY to 5 μS/CM and adjust C527 for linearity between pulses. Check for 5 ea 0.5 μs pulses in 10 cm, ±5%. There is interaction between R528 and C527.

18F. Adjust X25 Sweep Timing

Change the MAGNIFIER to X25, DISPLAY to 10μS/CM, and apply 0.5 μs markers. Preset C523 to midrange and adjust R524 for 8 ea 0.5 μs markers in 10 cm. Change DISPLAY to 5 μS/CM and adjust C523 for linearity between pulses. Check for 4 ea 0.5 μs pulses in 10 cm, ±5%. There is interaction between R524 and C523.

19. Check MAGNIFIER VARIABLE

Check MAGNIFIER VARIABLE for +20%, -20% change in timing. Also, check to see that the CALIB indicator extinguishes when VARIABLE is rotated out of the CALIB position.

20. Adjust FIELD 1 SYNC (R360A, B, C, D)

(a) Switch LINE AND FIELD RATE to 405/50 and apply 405/50 video. This system has a vertical block of eight pulses only, so adjust R360A to position the ramp immediately behind the eighth vertical serration. Then adjust R360A until the first horizontal sync pulse is superimposed about half way down the ramp, keeping away from the critical points in either direction where the ramp tends to latch up on either adjacent pulse. Check FIELD switch as described in the manual (step 21).

(b) Switch LINE AND FIELD RATE to 525/60 and apply 525/60 video. As described in the manual, adjust R360B so that the ramp starts after the sixth equalizing pulse and ends before the first horizontal sync pulse displayed on the test oscilloscope. Check FIELD switch as described in the manual (step 21).

(c) Switch LINE AND FIELD RATE to 625/50 and apply 625/50 video. Adjust R360C so that the ramp starts after the fifth equalizing pulse and ends before the first horizontal sync pulse displayed on the test oscilloscope. Check FIELD switch as described in the manual (step 21).

(d) Switch LINE AND FIELD RATE to 819/50 and apply 819/50 video. Adjust R360D so that the ramp starts after the seventh equalizing pulse and ends before the first horizontal sync pulse displayed on the test oscilloscope. Check FIELD switch as described in the manual (step 21). Return LINE AND FIELD RATE switch to 525/60 and apply 525/60 video.

21. Check FIELD Switch

Check is included in step 20.

22. Adjust SWP/MAG REGIS (R575)

Refer to the manual procedure.

23. Check Line Selector Brightening Pulse Amplitude

Refer to the manual procedure.

24. Adjust VIT LINE SEL RANGE (R458) and R461H

(a) Adjust R458 using the standard procedure with the LINE AND FIELD RATE switch set to 525/60. (Apply 525/60 composite video.)

(b) Switch LINE SELECTOR to 16 and observe brightened pulse on line 16.

(c) Switch LINE AND FIELD RATE to 625/50 and apply 625/50 composite video. Adjust R461H so that the brightened pulse is on line 16, by the CCIR system of counting (would be line 19, by the 525/60 system).

25A. Check Line Selector Operation

Refer to the manual procedure. Check 525/60 for approximately 1 1/4 field. Check the other three systems for a minimum of one field. (Apply appropriate composite video.)

25B. Check PAL FRAME SELECTOR Switch

(a) Apply 625/50 video and switch LINE AND FIELD RATE to 625/50. Set Horizontal DISPLAY to 2 FIELD and PAL FRAME SELECTOR to NORM.

(b) Connect a 10X probe from the collector of Q474 (TP474) to the test oscilloscope input.

(c) Connect a 1X probe from the test oscilloscope External Trigger Input to the base of Q474.

(d) Set the test oscilloscope controls as follows:

Volts/cm	5
Input Coupling	DC
Trigger Mode	DC
Trigger Slope	neg
Time/cm	5 ms

Set the Variable Time/cm to display 3 complete unblanking waveforms in 10 cm.

(e) Switch PAL FRAME SELECTOR to either extreme position (top or bottom). Check to see that the unblanking waveform displayed on the CRT switches to signal of equal amplitude and shape, but opposite polarity, as the PAL FRAME SELECTOR is switched from one extreme to the other.

26A. Check A DC CPLD Position of Vertical INPUT Switch

(a) Connect composite video to Channel A with INPUT set to A AC COUPLED.

(b) Turn DC RESTORER on and position trace to center of graticule.

(c) Change INPUT to A DC CPLD and check for no trace shift. (DC Restorer over-rides DC coupling.)

(d) Turn DC RESTORER off. Trace should move to the DC level of the input signal.

26B. Check Vertical Amplifier High-Frequency Response

Refer to the manual procedure, substituting the table on the following pages for Table 6-2 in the manual. Apply the signal to the upper VIDEO INPUT connector as indicated in the second column and terminate the appropriate lower VIDEO INPUT connector in 75 ohms.

27. Adjust Vertical-Amplifier 1.0 Flat-Frequency Response (C269, L162 and L262)

Refer to the manual procedure.

28. Adjust Vertical-Amplifier 0.2 Flat-Frequency Response (C118B)

Refer to the manual procedure.

1.10 MHz BAND PASS	A	CALIB	0.2	Adjust L136, C140B, and C140H (interaction) for 100 IRE units. Check for vertical deflection of 90 units or more at 0.9 and 1.3 MHz, and for 12.5 units or less at 200 kHz.
FLAT	A	CALIB	1.0	Set the constant amplitude sine-wave generator for 100 IRE units of reference amplitude at 50 kHz.
3.58 MHz BAND PASS	A	CALIB	1.0	Check for exactly 100 IRE units of vertical deflection at 3.58 MHz (center frequency); 65 to 85 units at 3.18 MHz and 3.98 MHz. If this frequency-response characteristic cannot be met, perform step 31.
FLAT	A	CALIB	0.2	Connect a modulated stairstep signal of 10 steps with 4.43 MHz bursts superimposed. Externally adjust the amplitude of the signal for 50 IRE units. The 4.43 MHz filter strips the stairstep providing bandpass filtering centered at 4.43 MHz with X2 gain.
4.43 MHz BAND PASS	A	CALIB	0.2	Adjust C140C and C140G (interaction) for 100 IRE units with best waveform response. At 3.93 MHz and at 5.13 MHz, 100 mV produces not more than 85% nor less than 65% of full scale deflection.

29. Adjust Vertical-Amplifier 0.5 Flat-Frequency Response (C118C)

Refer to the manual procedure.

30. Adjust Common Mode Rejection

Refer to the manual procedure.

31. Adjust Vertical Amplifier Chroma Frequency Response

Refer to the manual procedure.

32. Check J501 Staircase Input

An RCA 3-step generator and a GE 4-step generator will be required to complete the following steps.

a. Connect pin E of J501 to pin F (-25V).

b. Connect a composite video signal to input A and center the display with the Horizontal POSITION control.

c. Ground pin D of J501. The relay will close and display will be presented on the CRT.

d. With the Output Level R511, position the trace to the graticule center. The display will be either 2.5 cm long (for 4 steps) or 3.3 cm long (for 3 steps), depending upon the position of SW510.

Adjust Compensating Capacitor C507

a. Set the test oscilloscope Time/Div switch to 0.1 ms and connect the X10 probe to the emitter of Q554.

b. Connect the output of the Type 106 to J501 pin C. Set the Repetition Rate Range to 1 kHz.

c. Set the test oscilloscope Vertical to .05V, DC coupled and adjust the square wave generator for 5 V output.

d. Set the Horizontal DISPLAY to any line position and adjust the compensating capacitor, C507, for the best flat-level squarewave.

e. Disconnect the Type 106 generator. Disconnect the X10 probe and reconnect to pin C of J501.

Adjust Input Level R505 (for RCA 3-step generator only)

a. Connect the RCA 3-step generator to pin C of J501.

b. Set the test oscilloscope Vertical to 0.2V DC coupled and set Time/Div to 5 ms. Set Stairstep Selector switch SW510 to the 3-step position. Adjust the Input Level R505 for the best flat level of the 3-step generator input signal as viewed on the test oscilloscope. Also check the RM529 MOD 188D under calibration for equal separation between steps when adjusting R505.

c. Adjust the 3-step generator output control and check for 10 cm display of 3 sweep approximately 3.3 cm in length.

d. Disconnect the RCA 3-step generator and connect the GE 4-step generator to pin C of J501.

e. Set the Stairstep Selector switch SW510 to the 4-step position. Adjust the 4-step generator output control and check for a 10 cm display of 4 sweeps approximately 2.5 cm in length.

33. Adjust Bar Response of Pulse and Bar VIT Signal

Refer to the manual procedure. Set the DISPLAY switch to LINE SELECTOR 1 LINE.

PARTS LIST

The following changes should be made to the appropriate parts list for this modified instrument. When ordering replacement parts, specify instrument type, serial number, and MOD number. Include the circuit number, part number, and description of the desired item.

BULBS

B480A	Add	150-0034-00	28V RED
B480B	Add	150-0033-00	28V GREEN
B480C	Add	150-0091-00	28V BLUE
B480D	Add	150-0032-00	28V AMBER
B559	Add	150-0030-00	NE2V neon

CAPACITORS

C132B	Add	281-0594-00	150pF	100V	cer
C140A	Add	283-0602-00	53pF	300V	mica
C140B	Add	281-0092-00	9-35pF		var
C140C	Add	281-0091-00	2-8pF		var
C140D	Add	281-0617-00	15pF	200V	cer
C140F	Add	281-0601-00	7.5pF	500V	cer
C140G	Add	281-0093-00	5.5-18pF		var
C140H	Add	281-0091-00	2-8pF		var
C232B	Add	281-0594-00	150pF	100V	cer
C240D	Add	281-0617-00	15pF	200V	cer
C305	Add	283-0602-00	53pF	300V	mica
C341	Change	281-0536-00	1000pF	500V	cer
C342	Change	283-0059-00	1μF	25V	disc
C375	Change	281-0536-00	1000pF	500V	cer
C380	Add	283-0000-00	.001μF	500V	disc
C381	Add	283-0000-00	.001μF	500V	disc
C385	Change	281-0536-00	1000pF	500V	cer
C473	Add	283-0004-00	.02μF	150V	disc
C480	Add	285-0683-00	.022μF	100V	PTM
C481	Change	281-0022-00	8-50pF		var
C481A	Add	281-0022-00	8-50pF		var
C481B	Add	281-0022-00	8-50pF		var
C481C	Add	281-0022-00	8-50pF		var
C481D	Add	281-0022-00	8-50pF		var
C481E	Add	283-0641-00	180pF	100V	mica
C481F	Add	283-0641-00	180pF	100V	mica
C482	Change	283-0641-00	180pF	100V	mica
C482A	Add	283-0604-00	304pF	300V	mica
C482B	Add	283-0641-00	180pF	100V	mica
C482C	Add	283-0641-00	180pF	100V	mica
C482D	Add	283-0630-00	110pF	100V	mica
C482E	Add	283-0604-00	304pF	300V	mica
C482F	Add	283-0644-00	150pF		mica

C485	Add	283-0641-00	180pF	100V	mica
C486	Add	285-0598-00	.01μF	100V	PTM
C487	Add	281-0525-00	470pF	500V	cer
C501	Delete				
C502	Add	283-0111-00	.1μF	50V	disc
C507	Add	281-0022-00	8-50pF		var
C512	Add	281-0632-00	35pF	500V	cer
C516	Add	281-0513-00	27pF	500V	cer
C517	Delete				
C518	Add	281-0645-00	8.2pF	500V	cer
C520	Change	281-0557-00	1.8pF	500V	cer
C521	Add	281-0546-00	330pF	500V	cer
C523	Change	281-0031-00	3-12pF		var
C524	Add	281-0544-00	5.6pF	500V	disc
C526	Add	281-0510-00	22pF	500V	cer
C527	Add	281-0031-00	3-12pF		var
C552	Add	283-0119-00	.0022μF	200V	disc
C568	Add	285-0627-00	.003μF	100V	PTM
C578	Add	290-0145-00	10μF	50V	EMT
C640	Change	290-0130-00	2 x 125μF	350V	EMC
C650	Change	290-0017-00	125μF	450V	EMC
C651	Add	290-0213-00	10μF	450V	EMT
C654	Add	283-0002-00	.01μF	500V	disc
C850	Change	283-0087-00	300pF	1kV	disc
C1347	Add	281-0536-00	1000pF	500V	cer
C1375	Add	281-0536-00	1000pF	500V	cer
C1377	Add	283-0000-00	.001μF	500V	disc
C1385	Add	281-0536-00	1000pF	500V	cer
C1387	Add	281-0536-00	.001μF	500V	cer

DIODES

D341	Add	152-0185-00	6185
D344	Add	152-0185-00	6185
D375	Add	152-0107-00	1N647
D385	Add	152-0107-00	1N647
D434	Add	152-0185-00	6185
D464	Change	152-0061-00	6061
D510	Add	152-0185-00	6185
D519	Add	152-0168-00	1N963A, zener, 12V
D552	Add	152-0185-00	6185
D553	Change	152-0278-00	1N4372A, 3V zener
D554	Add	152-0166-00	1N635A, zener, 6.2V
D555	Add	152-0185-00	6185
D571	Delete		
D574	Add	152-0022-00	zener, 25V
D575	Add	152-0185-00	6185
D653	Add	152-0185-00	6185

D847	Change	152-0298-00	zener, 140V	
D1374	Add	152-0141-02	1N4152	
D1375	Add	152-0185-00	6185	
D1376	Add	152-0185-00	6185	
D1377	Add	152-0185-00	6185	
D1384	Add	152-0141-02	1N4152	
D1385	Add	152-0185-00	6185	
D1386	Add	152-0185-00	6185	
D1387	Add	152-0185-00	6185	

FUSES

F601	Change	159-0023-00	2A slo-blo, 3AG	
F637	Change	159-0018-00	.8Aslo-blo, 3AG	
F658	Add	159-0030-00	.3A fast-blo, 3AG	

RELAYS

K385	Delete			
K501	Add	148-0043-00	24V, 1325Ω, DPDT	

INDUCTORS

L132	Add	108-0237-00	80μH	
L133B	Add	108-0360-00	46μH	
L134B	Add	108-0459-00	36μH	
L136	Add	114-0253-00	280-470μH	var
L232	Add	108-0237-00	80μH	
L233B	Add	108-0360-00	46μH	

TRANSISTORS

Q344	Change	151-0133-00	Silicon
Q375	Change	151-0188-00	2N3906
Q385	Change	151-0188-00	2N3906
Q434	Change	151-0188-00	2N3906
Q474	Change	151-0124-00	2N3119
Q514	Add	151-1005-00	FET, silicon, N channel
Q524	Add	151-0188-00	2N3906
Q533	Change	151-0221-00	2N4258
Q544	Change	151-0124-00	2N3119
Q554	Add	151-0286-00	S26964
Q564	Add	151-0286-00	S26964
Q574	Change	151-0133-00	Silicon
Q653	Add	151-0155-00	2N2925
Q654	Add	151-0214-00	2N3495
Q657	Add	151-0149-00	2N3441
Q1375	Add	151-0188-00	2N3906
Q1385	Add	151-0188-00	2N3906

RESISTORS

R197	Change	316-0102-00		1k	1/4w	5%	
R341	Change	315-0103-00		10k	1/4w	5%	
R359	Add	323-0481-00		1M	1/2w	5%	
R360	Delete						
R360A	Add	311-0892-00		500k		var	
R360B	Add	311-0892-00		500k		var	
R360C	Add	311-0892-00		500k		var	
R360D	Add	311-0892-00		500k		var	
R362	Delete						
R362A	Add	315-0205-00		2M	1/4w	5%	
R362B	Add	315-0125-00		1.2M	1/4w	5%	
R362C	Add	315-0204-00		200k	1/4w	5%	
R362D	Add	315-0105-00		1M	1/4w	5%	
R373	Change	315-0224-00		220k	1/4w	5%	
R375	Change	315-0473-00		47k	1/4w	5%	
R376	Change	315-0272-00		2.7k	1/4w	5%	
R383	Change	315-0224-00		220k	1/4w	5%	
R385	Change	315-0473-00		47k	1/4w	5%	
R386	Change	315-0272-00		2.7k	1/4w	5%	
R418	Change	323-0304-00	Sel	14.3k	1/2w	1%	prec
R419	Change	323-0424-00	Sel	255k	1/2w	1%	prec
R453	Change	303-0223-00		22k	1/2w	5%	
R458	Change	311-0465-00		100k		var	
R461H	Add	311-0579-00		20k		var	
R472	Change	315-0224-00		220k	1/4w	5%	
R473	Change	315-0433-00		43k	1/4w	5%	
R476	Add	315-0393-00		39k	1/4w	5%	
R479	Add	315-0123-00		12k	1/4w	5%	
R480A	Add	308-0231-00		220Ω	3w	5%	ww
R480D	Add	308-0252-00		390Ω	3w	5%	ww
R482	Change	321-0404-00		158k	1/8w	1%	prec
R483	Change	323-0488-00		1.18M	1/2w	1%	prec
R484	Change	321-0415-00		205k	1/8w	1%	prec
R491	Change	315-0512-00		5.1k	1/4w	5%	
R492	Change	321-0322-00		22.1k	1/8w	1%	prec
R494	Add	311-0510-00		10k		var	
R495	Add	316-0105-00		1M	1/4w	10%	
R501	Delete						
R502	Delete						
R503	Add	315-0224-00		220k	1/4w	5%	
R504	Delete						
R505	Add	311-0893-00		5M		var	
R507	Add	323-0668-00		1.442M	1/2w	1/4%	prec
R508	Add	323-0737-00		3.935M	1/2w	1%	prec
R510	Add	301-0513-00		51k	1/2w	5%	
R511	Add	311-0465-00		100k		var	

R512	Add	323-0498-00	1.5M	1/4w	5%	
R513	Add	315-0475-00	4.7M	1/4w	5%	
R514	Change	315-0393-00	39k	1/4w	5%	
R515	Add	315-0125-00	1.2M	1/4w	5%	
R516	Change	321-0346-00	39.2k	1/8w	1%	prec
R517	Delete					
R518	Add	323-0388-00	107k	1/2w	1%	prec
R519	Add	301-0223-00	22k	1/2w	5%	
R520	Change	323-0437-00	348k	1/2w	1%	prec
R522	Change	321-0316-00	19.1k	1/8w	1%	prec
R523	Change	321-0382-00	93.1k	1/8w	1%	prec
R524	Add	311-0326-00	10k		var	
R526	Add	321-0345-00	38.3k	1/8w	1%	prec
R527	Add	321-0372-00	73.2k	1/8w	1%	prec
R528	Add	311-0326-00	10k		var	
R544	Change	315-0683-00	68k	1/4w	5%	
R551	Delete					
R552	Change	301-0363-00	36k	1/2w	5%	
R553	Change	315-0105-00	1M	1/4w	5%	
R554	Change	308-0178-00	15k	8w	5%	ww
R555	Add	315-0240-00	24Ω	1/4w	5%	
R556	Change	323-0235-00	2.7k	1/2w	1%	prec
R557	Add	311-0891-00	100Ω		var	
R558	Change	315-0100-00	10Ω	1/4w	5%	
R559	Add	316-0224-00	220k	1/4w	10%	
R561	Delete					
R564	Change	308-0178-00	15k	8w	5%	ww
R566	Change	323-0235-00	2.74k	1/2w	1%	prec
R568	Change	311-0433-00	100Ω		var	
R571	Change	301-0363-00	36k	1/2w	5%	
R574	Change	315-0153-00	15k	1/4w	5%	
R575	Change	311-0462-00	1k		var	
R576	Change	322-0261-00	5.11k	1/4w	1%	prec
R577	Add	308-0429-00	22k	2.5w	1%	ww
R578	Add	321-0641-00	1.8k	1/8w	1%	
R651	Add	324-0415-00	205k	1w	1%	prec
R652	Add	308-0212-00	10k	3w	5%	ww
R653	Add	323-0306-00	15k	1/2w	1%	prec
R654	Add	316-0102-00	1k	1/4w	10%	
R656	Add	302-0102-00	1k	1/2w	10%	
R657	Add	315-0104-00	100k	1/4w	5%	
R658	Add	316-0221-00	220Ω	1/4w	10%	
R659	Add	304-0120-00	12Ω	1w	10%	
R855	Change	311-0892-00	500k		var	
R864	Change	311-0552-00	1M		var	
R886	Change	321-0014-00	13.7Ω	1/8w	1%	prec
R887	Add	321-0178-00	698Ω	1/8w	1%	prec
R1347	Add	315-0103-00	10k	1/4w	5%	

R1373	Add	316-0105-00	1M	1/4w	10%
R1374	Add	315-0472-00	4.7k	1/4w	5%
R1375	Add	316-0473-00	47k	1/4w	10%
R1376	Add	316-0105-00	1M	1/4w	10%
R1377	Add	316-0473-00	47k	1/4w	10%
R1378	Add	316-0473-00	47k	1/4w	10%
R1383	Add	316-0105-00	1M	1/4w	10%
R1384	Add	315-0472-00	4.7k	1/4w	5%
R1385	Add	316-0473-00	47k	1/4w	10%
R1386	Add	316-0105-00	1M	1/4w	10%
R1387	Add	316-0473-00	47k	1/4w	10%
R1388	Add	316-0473-00	47k	1/4w	10%
R1389	Add	316-0473-00	47k	1/4w	10%

SWITCHES

SW101	Change	260-1016-00	Vertical INPUT
SW135	Change	260-0915-01	Vertical RESPONSE
SW430	Change	260-1015-00	HORIZ DISPLAY
SW480	Add		LINE AND FIELD RATE
SW510	Add	260-0723-00	Stairstep selector
SW520	Change	260-1017-00	HORIZ MAGNIFIER
SW557	Add	311-0891-00*	VARIABLE magnifier
SW885	Change	260-0546-00	CALIBRATOR
SW1380	Add	260-0396-00	PAL FRAME SELECTOR

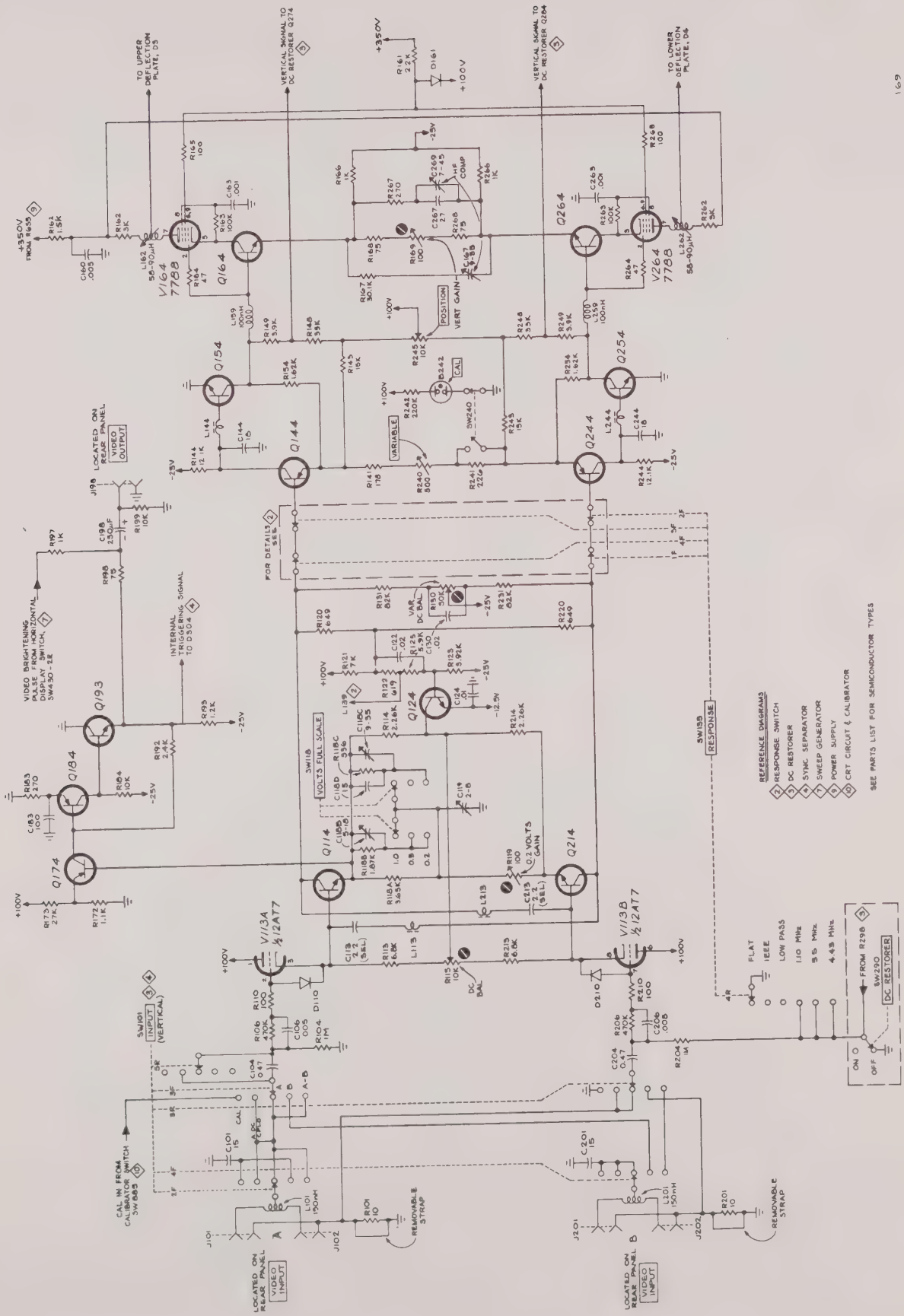
TRANSFORMERS

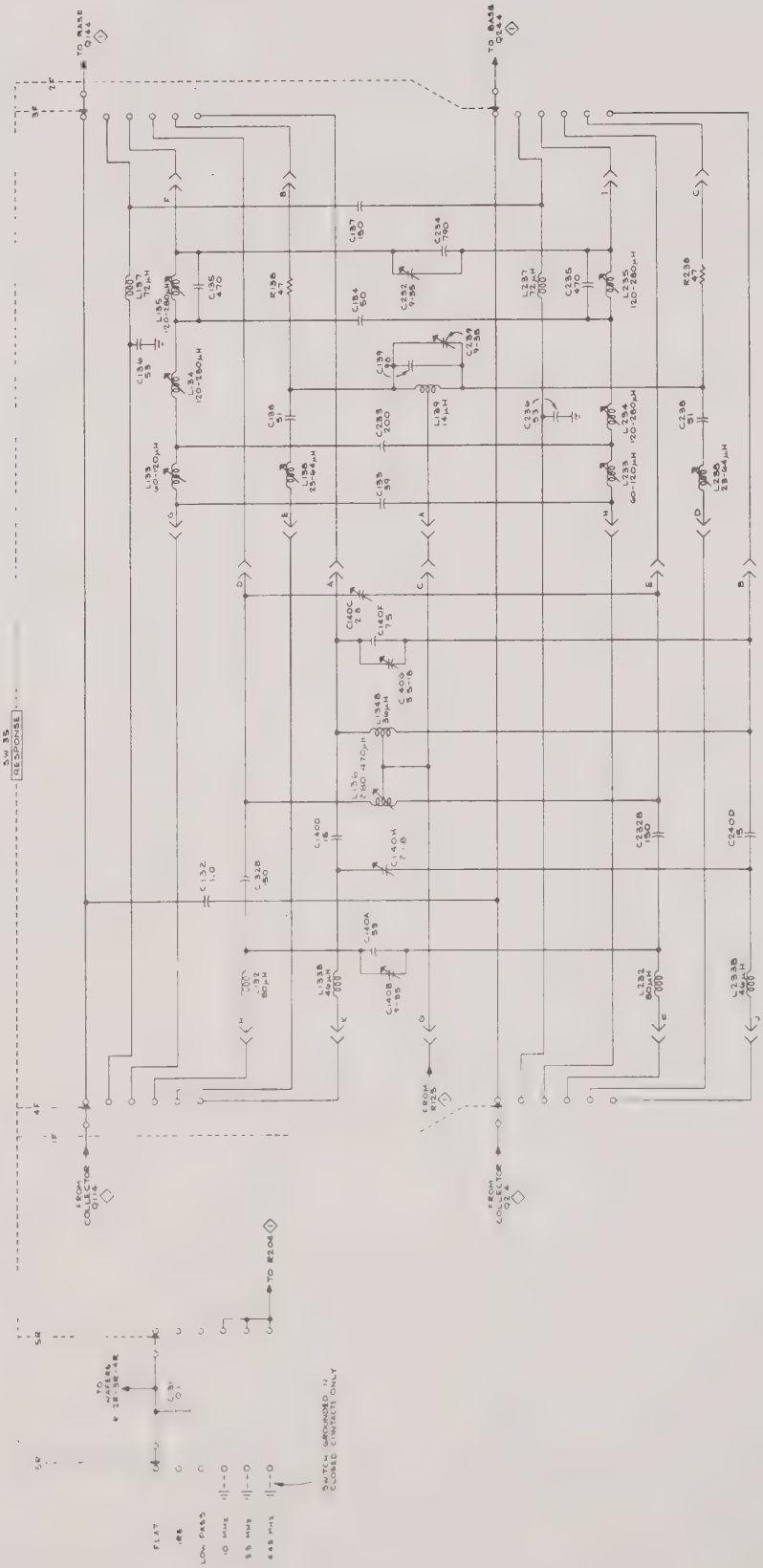
T601	Change	120-0577-00	L.V.Power Supply

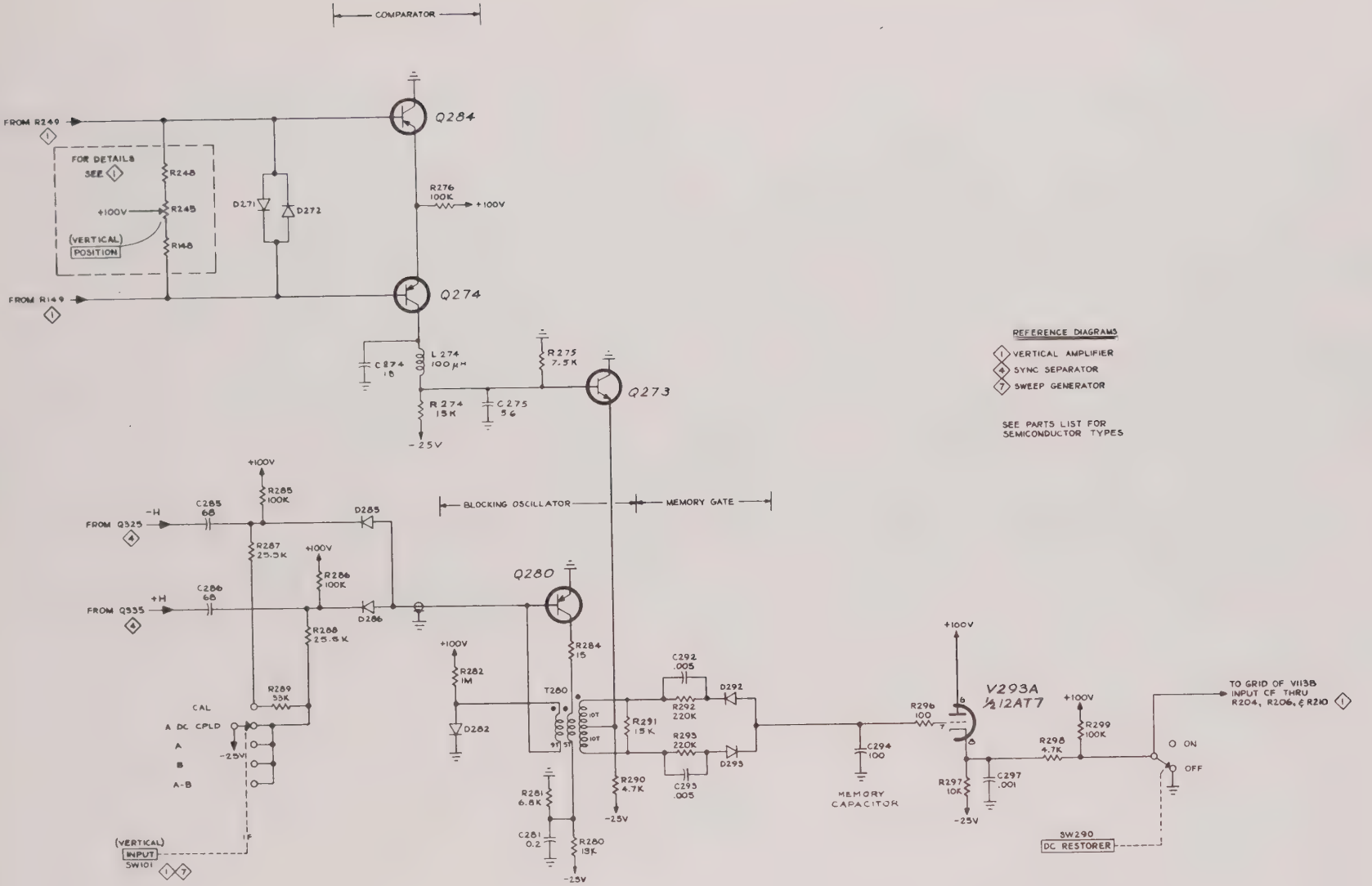
TUBES

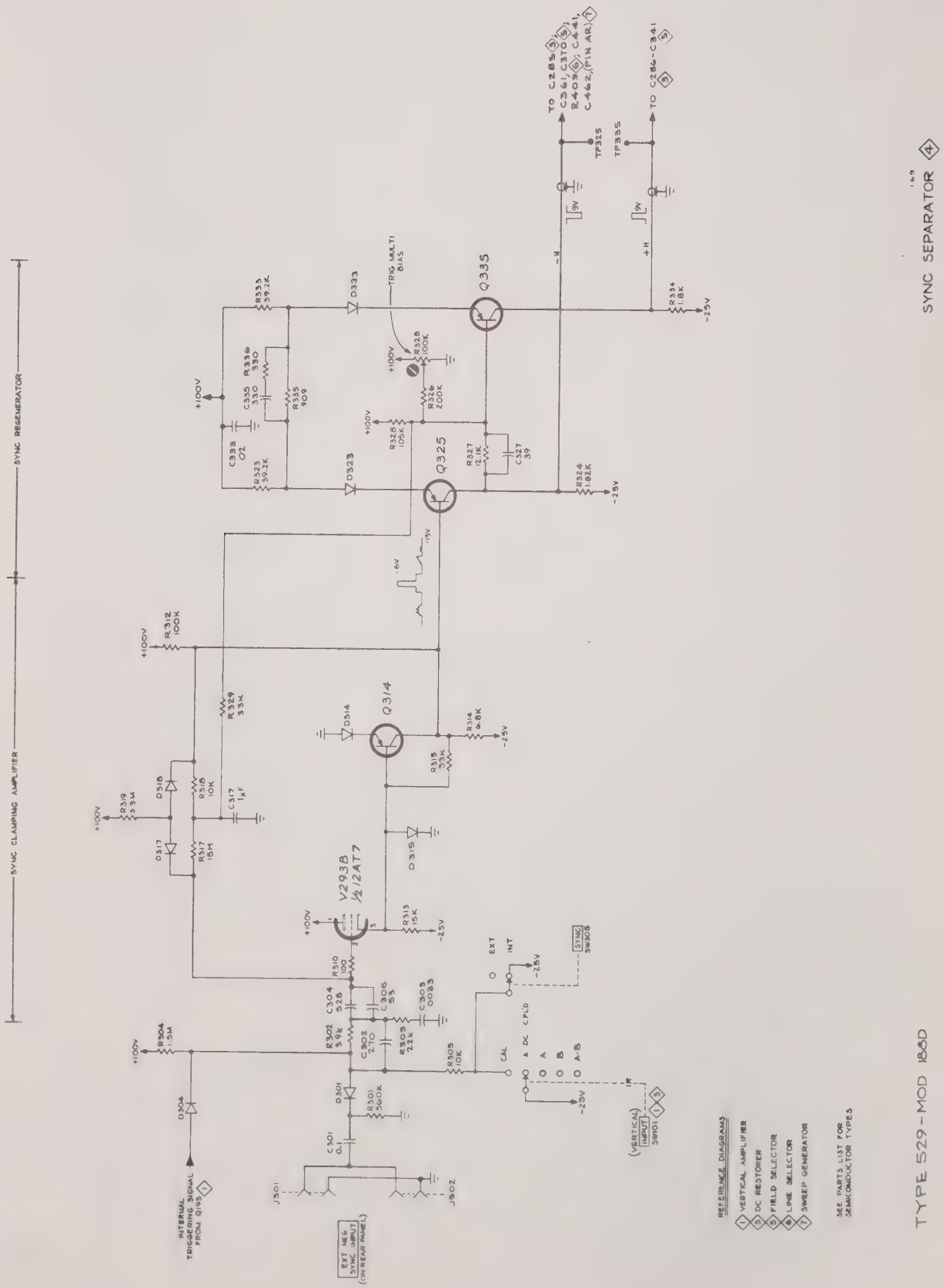
V554	Delete

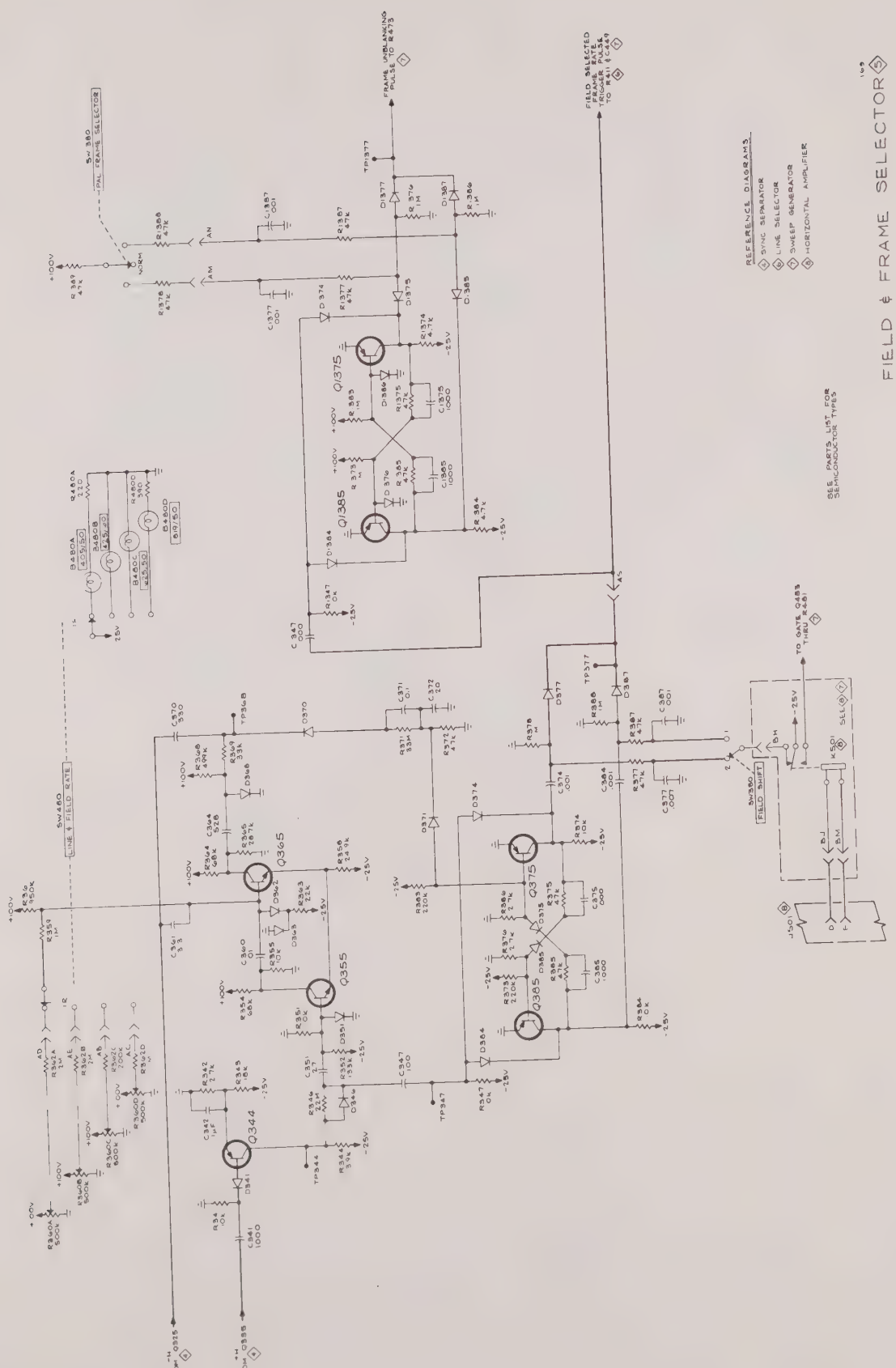
*Furnished as a unit with R557.

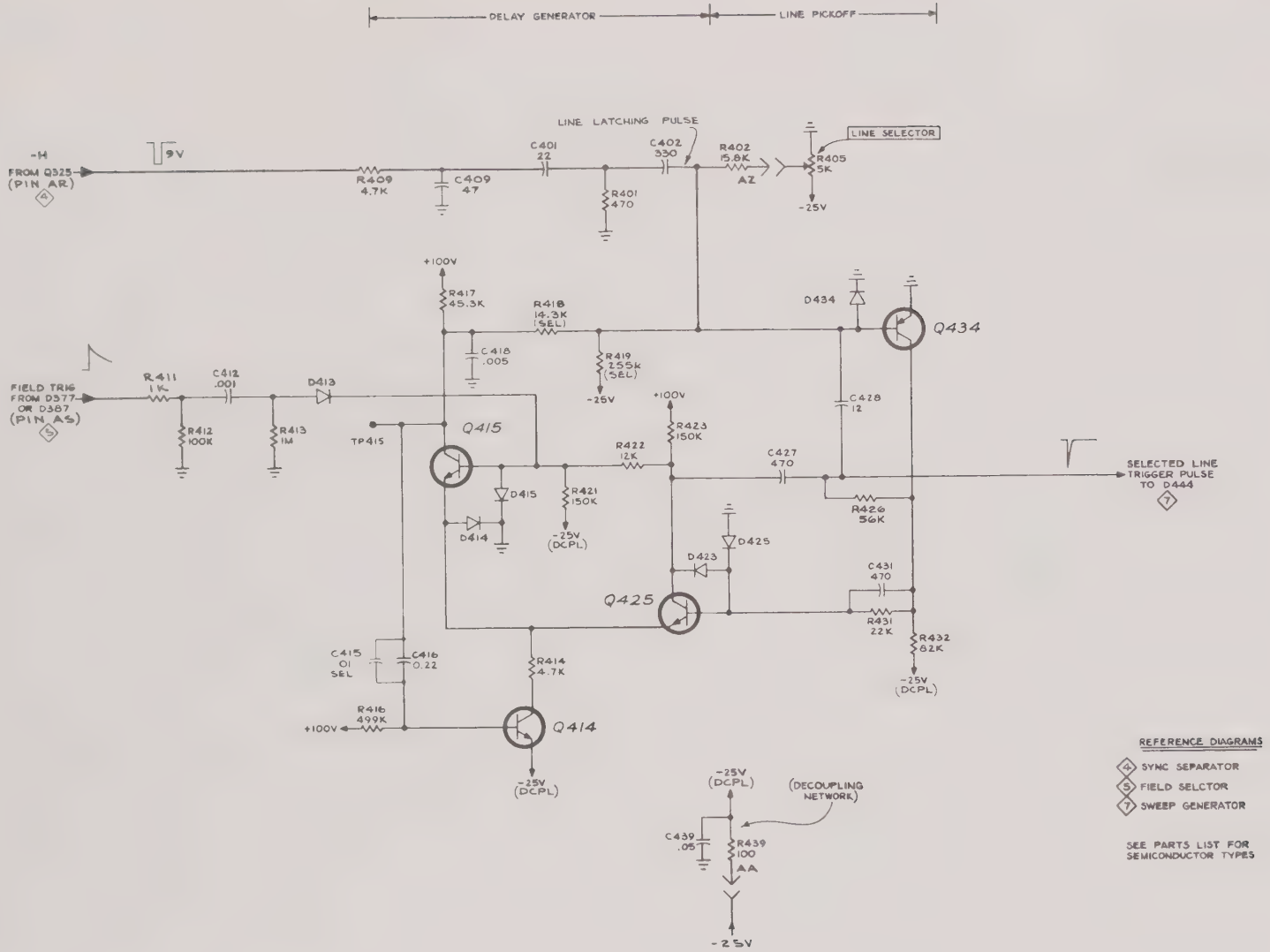

VERTICAL AMPLIFIER
TYPE 529 - MOD 188D
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
REFERENCE DIAGRAMS
2 RESPONSE SWITCH
3 DC RESTORER
4 SYNC SEPARATOR
7 SWEEP GENERATOR
8 POWER SUPPLY
10 CRT CIRCUIT & CALIBRATOR
TO UPPER DEFLECTION PLATE, D8
TO LOWER DEFLECTION PLATE, D4
VERTICAL SIGNAL TO DC RESTORER Q274
VERTICAL SIGNAL TO DC RESTORER Q284
+350V
+100V
-25V
-12.5V
VIDEO BRIGHTENING PULSE FROM HORIZONTAL DISPLAY SWITCH, SW450-2E
INTERNAL TRIGGERING SIGNAL TO D504
CAL IN FROM CALIBRATOR SWITCH SW685
LOCATED ON REAR PANEL VIDEO INPUT
LOCATED ON REAR PANEL VIDEO OUTPUT
REMOVABLE STRAP
FROM R298 SW290 DC RESTORER
FLAT
IEEE
LOW PASS
110 MHz
95 MHz
4.45 MHz
ON
OFF
SW139 RESPONSE
SW118 VOLTS FULL SCALE
0.2 VOLTS GAIN
VAR DC BAL
DC BAL
POSITION
VERT GAIN
CAL
VARIABLE
FOR DETAILS SEE 2
SW101 INPUT (VERTICAL)
A
B
A+B
CAL
ABCD
V164 7788
V264 7788
V113A 1/2 12AT7
V113B 1/2 12AT7
Q164
Q264
Q54
Q254
Q144
Q244
Q93
Q184
Q174
Q124
Q114
Q214
J101
J102
J201
J202
L101 150nH
L201 150nH
L162 58-90μH
L262 58-90μH

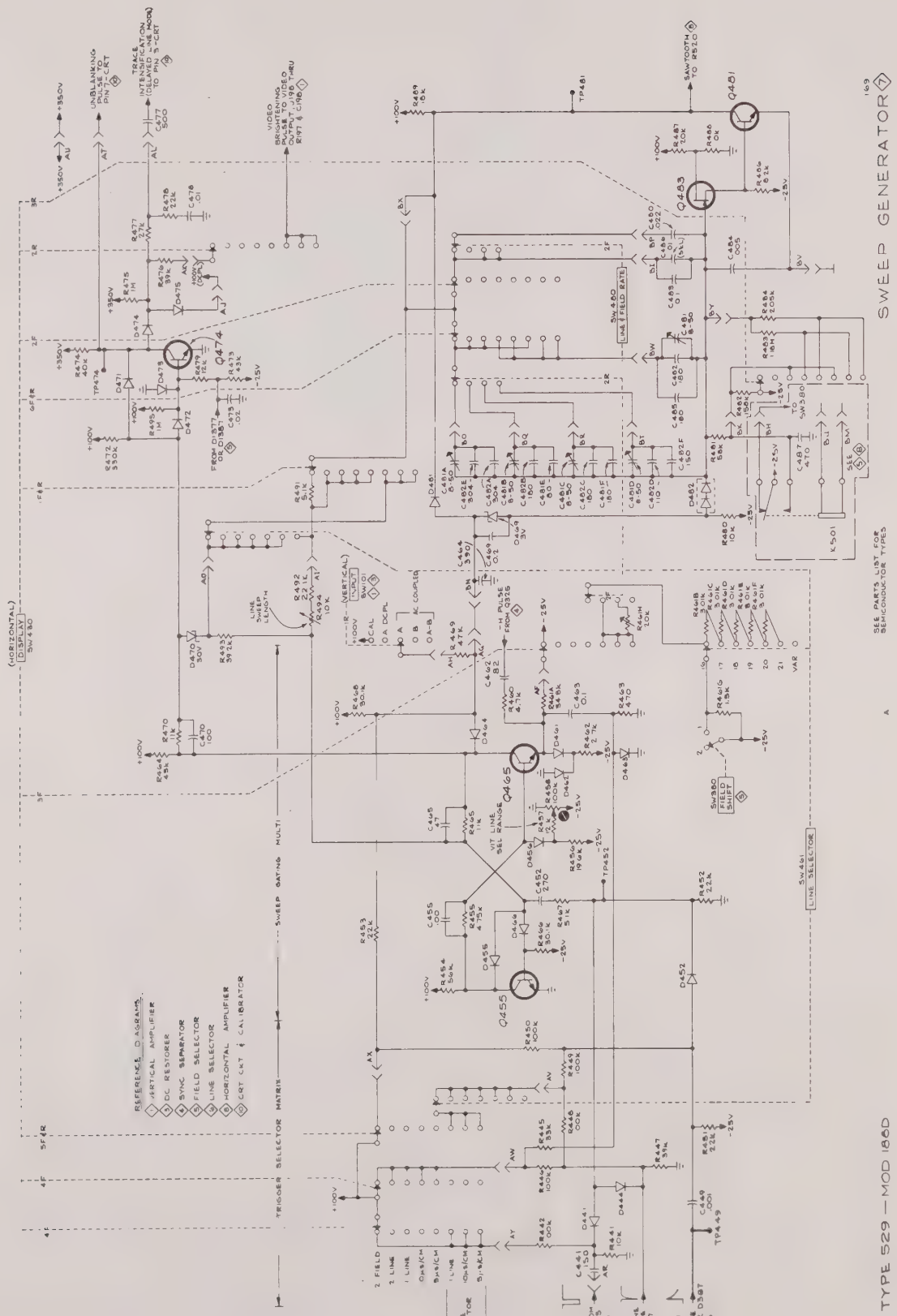

RESPONSE SWITCH
TYPE 529 - MOD 188D
REFERENCE DIAGRAMS
VERTICAL AMPLIFIER
TO BASE Q144
TO BASE Q244
FROM COLLECTOR Q134
FROM COLLECTOR Q234
TO R204
SW 35 RESPONSE
FLAT
RS
LOW PASS
10 MHz
5.5 MHz
4.5 MHz
SWITCH GROUNDED IN CLOSED CONTACTS ONLY

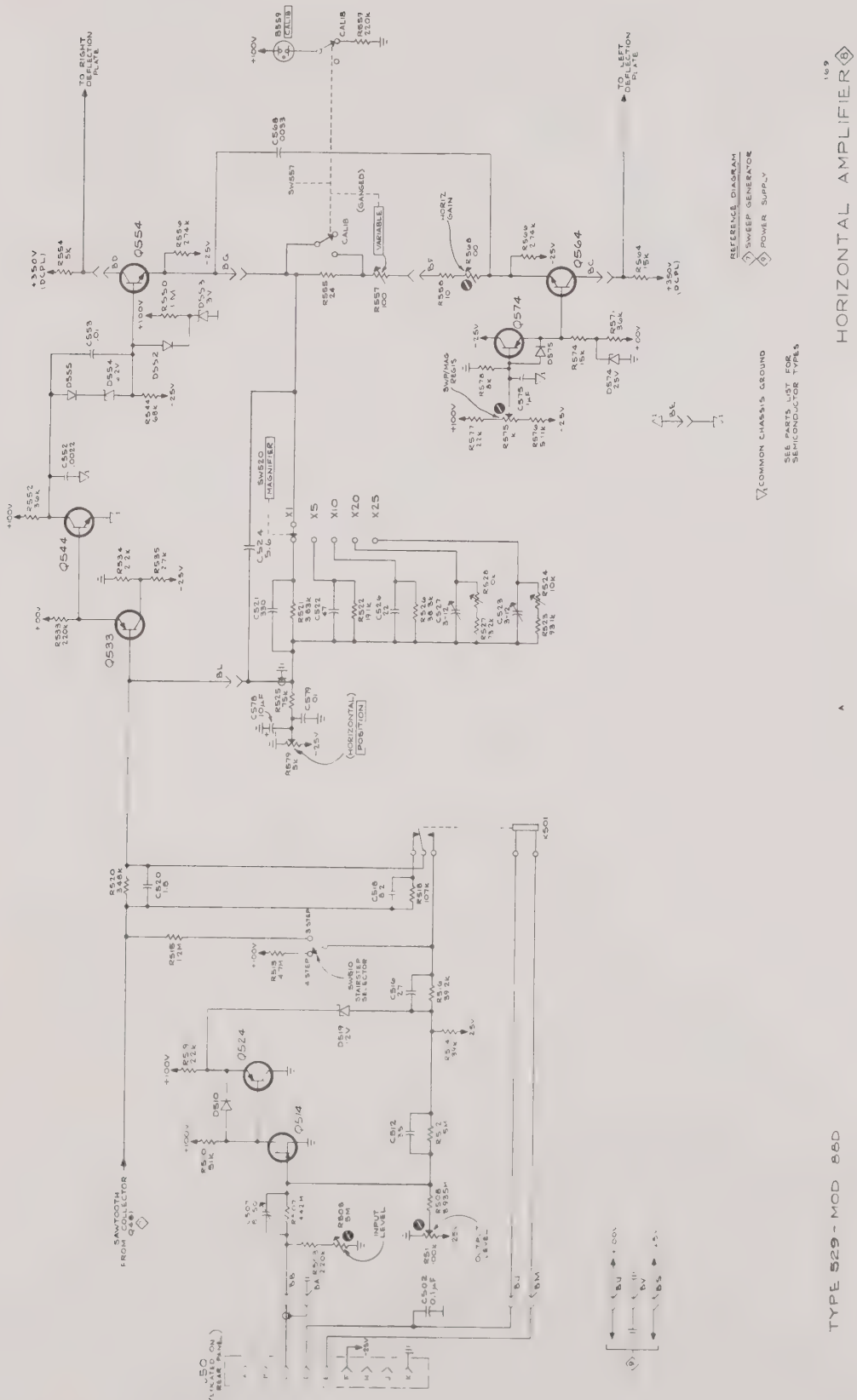

COMPARATOR
FROM R249
FOR DETAILS SEE 1
R248
+100V
R245
(VERTICAL) POSITION
R148
FROM R149
Q284
Q274
D271
D272
R276 100K
+100V
C274 18
L274 100μH
R275 7.5K
Q273
R274 15K
C275 56
-25V
REFERENCE DIAGRAMS
1 VERTICAL AMPLIFIER
4 SYNC SEPARATOR
7 SWEEP GENERATOR
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
BLOCKING OSCILLATOR
MEMORY GATE
+100V
R285 100K
C285 68
-H
FROM Q325
D285
R287 25.5K
R286 100K
C286 68
+H
FROM Q335
D286
R288 25.5K
Q280
R284 15
R282 1M
D282
T280
R289 33K
CAL
A DC CPLD
A
B
A-B
-25V
(VERTICAL) INPUT SW101
1F
R281 6.8K
C281 0.2
R280 13K
-25V
R291 15K
R290 4.7K
-25V
C292 .005
R292 220K
D292
R293 220K
D293
C293 .005
C294 100
MEMORY CAPACITOR
+100V
R296 100
V293A
½12AT7
R297 10K
-25V
C297 .001
+100V
R299 100K
R298 4.7K
O ON
OFF
SW290
DC RESTORER
TO GRID OF V113B INPUT CF THRU R204, R206, & R210 1

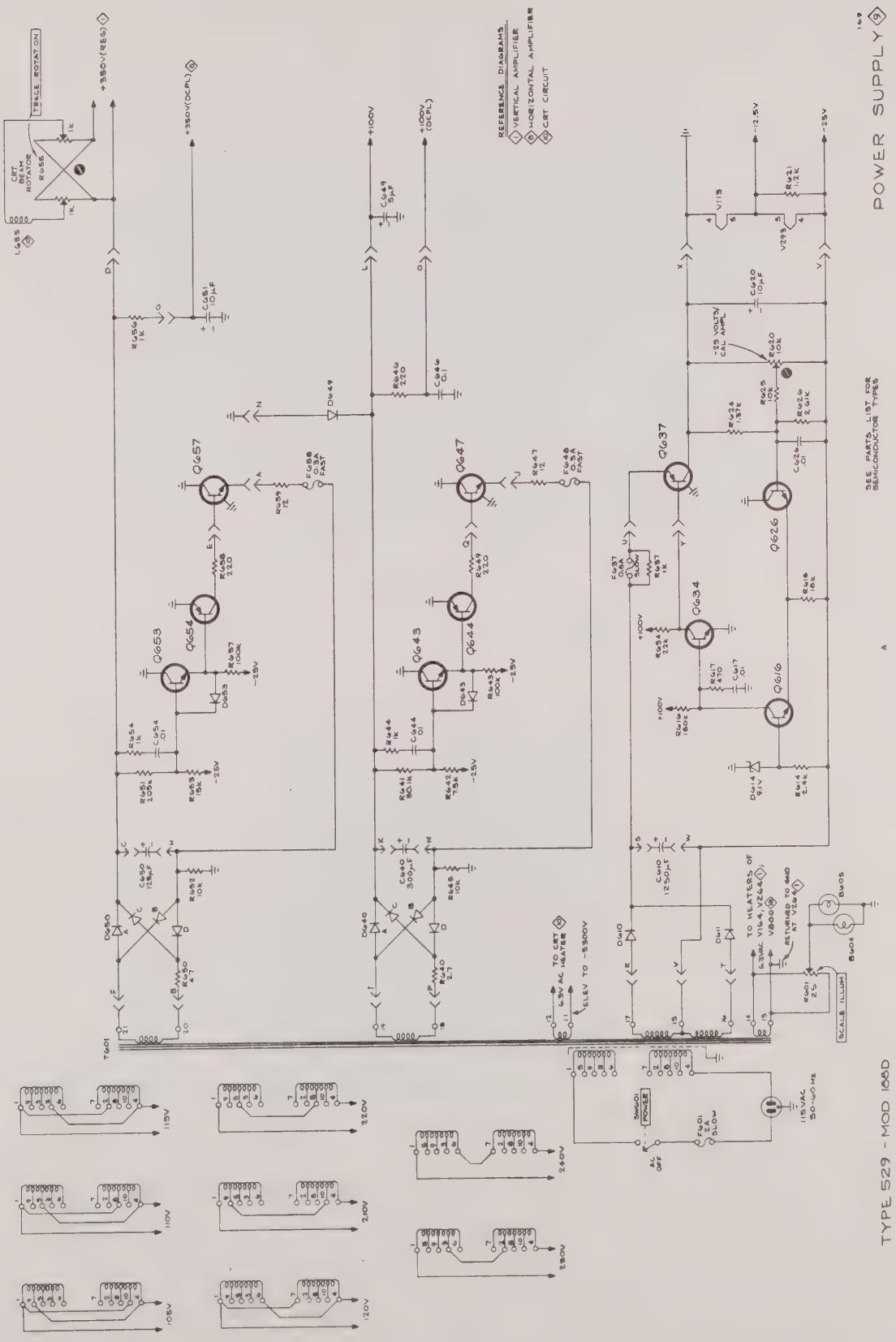

SYNC CLAMPING AMPLIFIER
SYNC REGENERATOR
SYNC SEPARATOR
Q335
Q325
Q314
V2938
½ 12AT7
TRIG MULTI BIAS
+100V
-25V
-19V
-6V
TO C285, C341, C310, R409, C441, C462, (PIN AR.)
TO C286-C341
TP325
TP335
INTERNAL TRIGGERING SIGNAL FROM GYSTAL
EXT NEG SYNC INPUT (ON REAR PANEL)
J301
J302
(VERTICAL INPUT SW101)
SYNC SW305
EXT
INT
CAL
A DC CPLD
A
B
A-B
REFERENCE DIAGRAMS
1 VERTICAL AMPLIFIER
3 DC RESTORER
5 FIELD SELECTOR
6 LINE SELECTOR
7 SWEEP GENERATOR
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

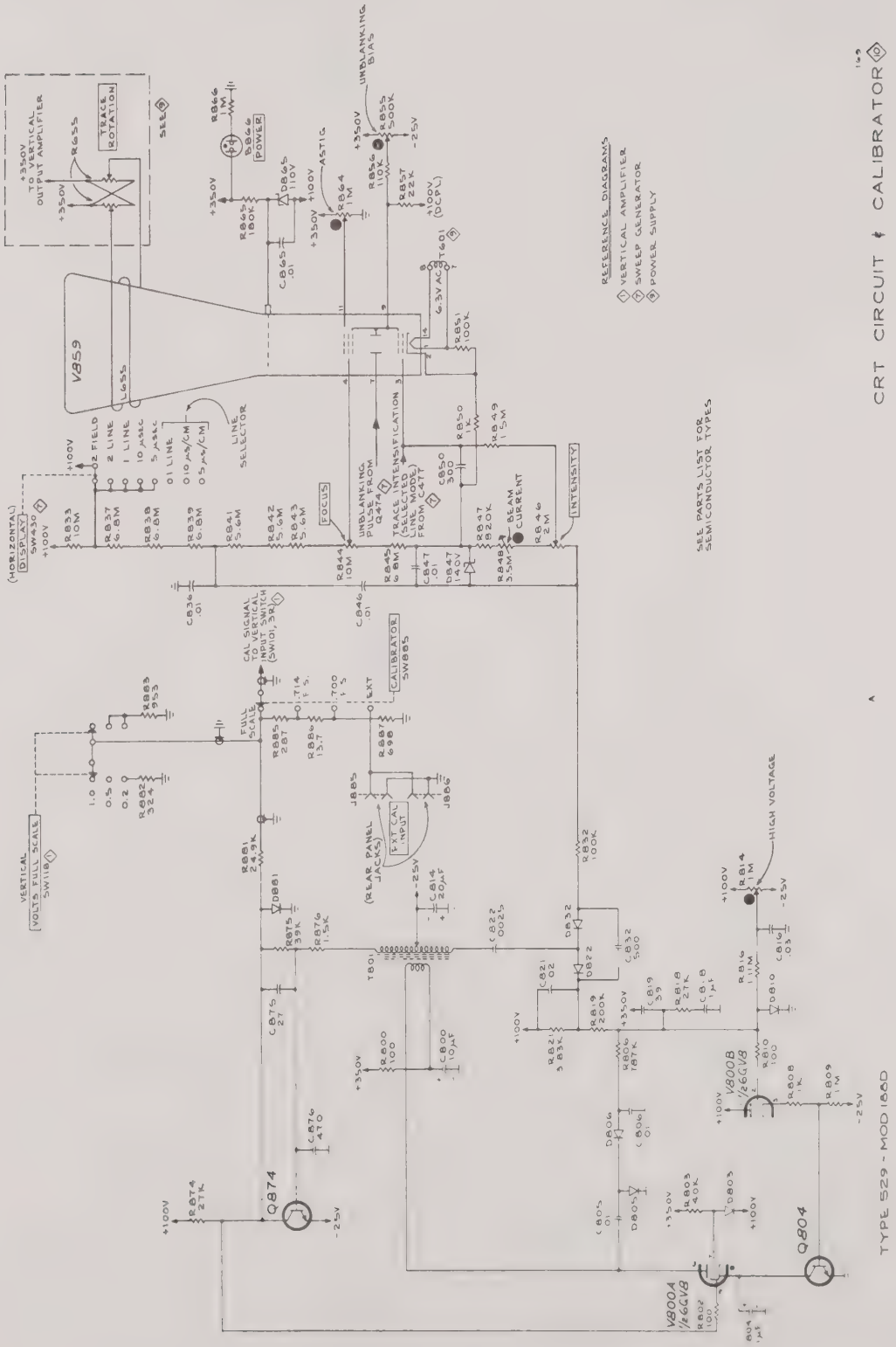

FIELD & FRAME SELECTOR
TYPE 529 - MOD 188D
REFERENCE DIAGRAMS
SYNC SEPARATOR
LINE SELECTOR
SWEEP GENERATOR
HORIZONTAL AMPLIFIER
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
FIELD SELECTED FRAME RATE FROM R441 & C449
FRAME UNBLANKING PULSE TO R473
TO GATE Q485 THRU R481
SW 380 PAL FRAME SELECTOR
SW 480 LINE & FIELD RATE
SW 360 FIELD SHIFT
Q335
Q345
Q355
Q365
Q375
Q385
Q344
Q354
Q364
Q374
Q384
Q1375
Q1385

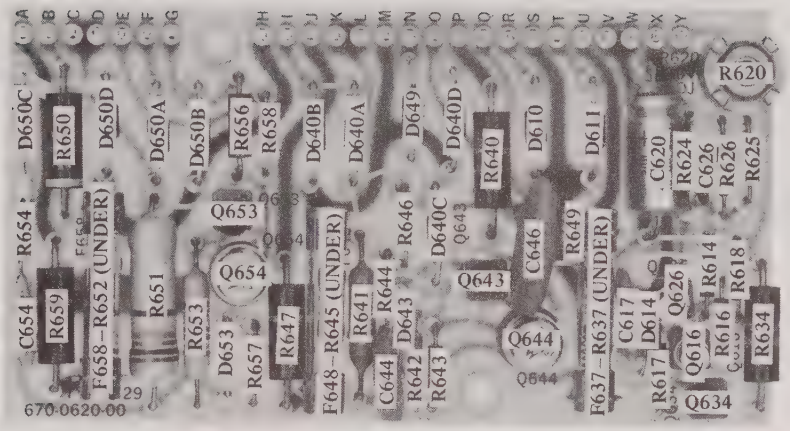

DELAY GENERATOR
LINE PICKOFF
LINE LATCHING PULSE
LINE SELECTOR
-H
FROM Q325 (PIN AR)
9V
R409 4.7K
C409 47
C401 22
C402 330
R402 15.8K
AZ
R405 5K
-25V
R401 470
+100V
R417 45.3K
R418 14.3K (SEL)
C418 .005
R419 255K (SEL)
D434
Q434
C428 12
FIELD TRIG FROM D377 OR D387 (PIN AS)
R411 1K
C412 .001
D413
R412 100K
R413 1M
TP415
Q415
R423 150K
R422 12K
C427 470
SELECTED LINE TRIGGER PULSE TO D444
D415
R421 150K
D414
-25V (DCPL)
R426 56K
D425
D423
C431 470
Q425
R431 22K
R432 82K
C415 .01 SEL
C416 0.22
R414 4.7K
R416 499K
Q414
(DECOUPLING NETWORK)
C439 .05
R439 100 AA
REFERENCE DIAGRAMS
4 SYNC SEPARATOR
5 FIELD SELCTOR
7 SWEEP GENERATOR
SEE PARTS LIST FOR SEMICONDUCTOR TYPES


SWEEP GENERATOR
TYPE 529 — MOD 188D
TRIGGER SELECTOR MATRIX — SWEEP GATING MULTI
REFERENCE DIAGRAMS
VERTICAL AMPLIFIER
DC RESTORER
SYNC SEPARATOR
FIELD SELECTOR
LINE SELECTOR
HORIZONTAL AMPLIFIER
CRT CKT & CALIBRATOR
(HORIZONTAL) DISPLAY SW 490
(VERTICAL) DISPLAY SW 480
SW 460 LINE & FIELD RATE
SW 461 LINE SELECTOR
SW 380 FIELD SHIFT
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
Q455
Q465
Q474
Q481
Q483
K501
+100V
+350V
-25V
-150V
SAWTOOTH TO PS10
UNBLANKING PULSE TO PN 7 CRT
TRACE INTENSIFICATION (VIEWING INTENSIFICATION) TO PN 5 CRT
VIDEO BRIGHTENING PULSE TO OUTPUT J198 THRU R197 & CIN8
FROM D377 OR D387
SELECTED LINE TRIGGER PULSE FROM C427
FIELD SELECTED TRIGGER RATE PULSES FROM D377 OR D387 (PIN A5)
-M PULSE FROM Q325
+M PULSE FROM Q325
2 FIELD
2 LINE
1 LINE
.05ms/CM
.5ms/CM
1 LINE
.05ms/CM
.5ms/CM
LINE SELECTOR

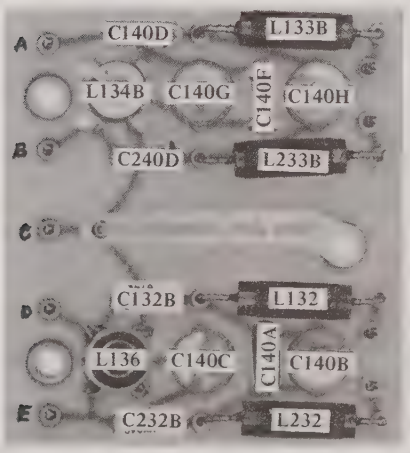

HORIZONTAL AMPLIFIER
TYPE 529 - MOD 88D
REFERENCE DIAGRAM
SWEEP GENERATOR
POWER SUPPLY
COMMON CHASSIS GROUND
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
TO RIGHT DEFLECTION PLATE
TO LEFT DEFLECTION PLATE
Q554
Q564
Q574
Q544
Q533
Q524
Q514
Q504
MAGNIFIER
X1
X5
X10
X20
X25
HORIZONTAL POSITION
CAL IB
VARIABLE
HORIZ GAIN
INPUT LEVEL
4 STEP
SWP/MAG REG'S
SAWTOOTH FROM COLLECTOR


POWER SUPPLY
TYPE 529 - MOD 188D
REFERENCE DIAGRAMS
VERTICAL AMPLIFIER
HORIZONTAL AMPLIFIER
CRT CIRCUIT
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
TRACE ROTATION
CRT BEAM ROTATOR R656
+350V(REG)
+350V(DCPL)
+100V
+100V (DCPL)
-12.5V
-25V
-25 VOLTS CAL AMPL
Q657
Q654
Q653
Q647
Q644
Q643
Q637
Q634
Q626
Q616
T601
SCALE ILLUM
TO CRT HEATER
ELEV TO -3500V
TO HEATERS OF
RETURNED TO 940
AT V264
AC OFF POWER
115VAC 50-60 Hz
115V
110V
105V
220V
210V
120V
240V
230V

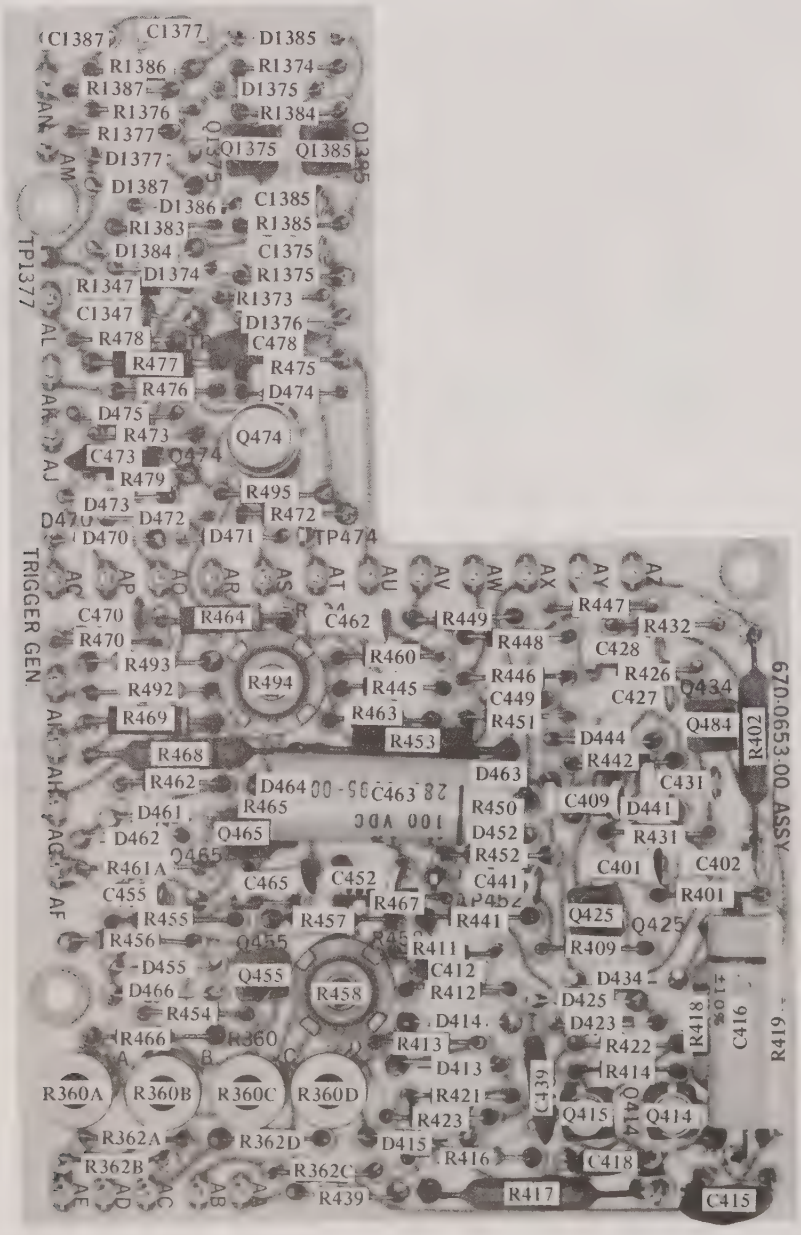

CRT CIRCUIT & CALIBRATOR
TYPE 529 - MOD 188D
REFERENCE DIAGRAMS
VERTICAL AMPLIFIER
SWEEP GENERATOR
POWER SUPPLY
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
V859
Q874
Q804
V8004 1/2 6AV8
V8008 1/2 6AV8
+350V TO VERTICAL OUTPUT AMPLIFIER
TRACE ROTATION
R855
R866 1M
R866 BEAM POWER
R865 180K
C865 .01
D865 110V
R864 1M
ASTIG
R856 110K
R855 500K
UNBLANKING BIAS
R857 22K
-25V
+100V (DCPL)
6.3V ACCT601
R851 100K
R850 1K 1W
R849 1.5M
R847 820K
R848 2.5M
BEAM CURRENT
R846 2M
INTENSITY
C850 .30
C847 .01
D847 140V
C846 .01
C844 .01
R844 10M
R845 6.8M
FOCUS
UNBLANKING PULSE FROM Q474
TRACE INTENSIFICATION (SELECTED LINES ONLY) FROM C471
R842 5.6M
R843 5.6M
R841 5.6M
R839 6.8M
R838 6.8M
R837 6.8M
R833 10M
+100V
.2 FIELD
2 LINE
1 LINE
10 μsec
5 μsec
.1 LINE
.10 μs/CM
.05 μs/CM
LINE SELECTOR
(HORIZONTAL) DISPLAY SW430
CAL SIGNAL TO VERTICAL INPUT SWITCH (SW101, 32)
CALIBRATOR SW885
FULL SCALE
EXT
.714 F.S.
.700 F.S.
R885 287
R886 13.7
R887 698
R883 953
R882 324
1.0
0.5
0.2
VERTICAL VOLTS/FULL SCALE SW118
R881 2.43K
D881
R875 39K
R876 1.15K
C875 27
R874 27K
C874 470
R800 100
C800 10μF
+350V
+100V
-25V
C814 20μF
(REAR PANEL JACKS)
J885
J886
EXT CAL INPUT
C822 .0025
T801
D832
D822
R832 100K
C832 500
C821 .02
R819 200K
R821 383K
R806 187K
C819 39
R818 27K
C818 1μF
R816 1.11M
C816 .05
D810
R814 1M
HIGH VOLTAGE
R810 100
R808 1K
R809 1M
C810
D804
C804 .01
D805
R803 40K
D803
C803 .01
C802 .1μF
R802 100
C804 .1μF



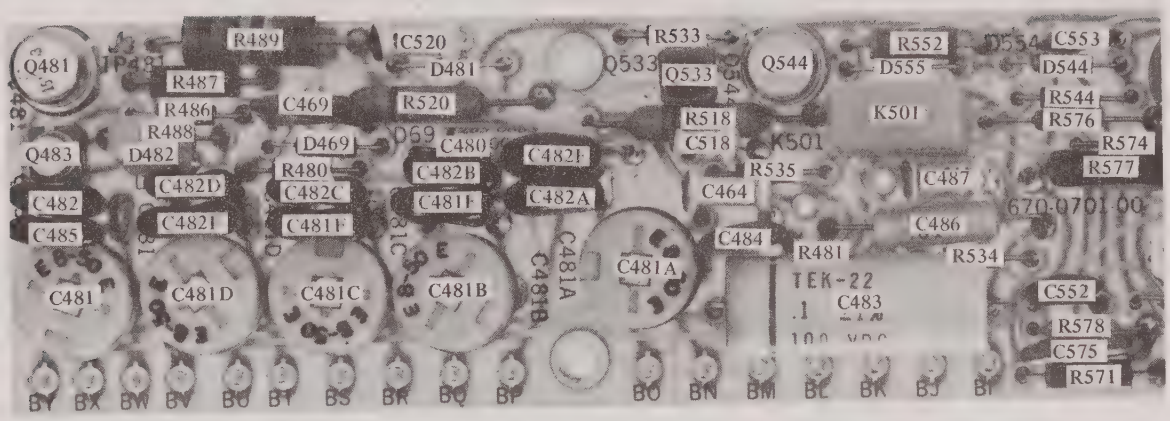
LOW VOLTAGE POWER SUPPLY CIRCUIT BOARD



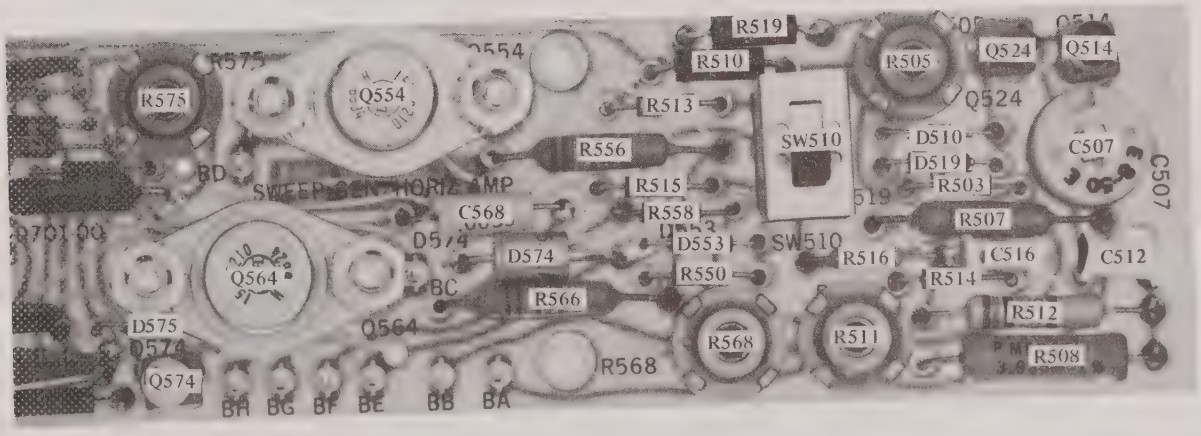
BANDPASS CIRCUIT BOARD



TRIGGER GEN CIRCUIT BOARD



SWEEP GEN/HORIZ AMP CIRCUIT BOARD
(PARTIAL)



SWEEP GEN/HORIZ AMP CIRCUIT BOARD
(PARTIAL)

INSTRUCTION MANUAL

Serial Number _____

TYPE 529 WAVEFORM MONITOR

Tektronix, Inc.
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-0509-01

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial or Model Number with all requests for parts or service.

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CONTENTS

Section 1	Characteristics
Section 2	Operating Instructions
Section 3	Circuit Description
Section 4	Maintenance
Section 5	Performance Check
Section 6	Calibration
	Abbreviations and Symbols
	Parts Ordering Information
Section 7	Electrical Parts List
Section 8	Mechanical Parts List
Section 9	Diagrams

Abbreviations and symbols used in this manual are based on, or taken directly from, IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

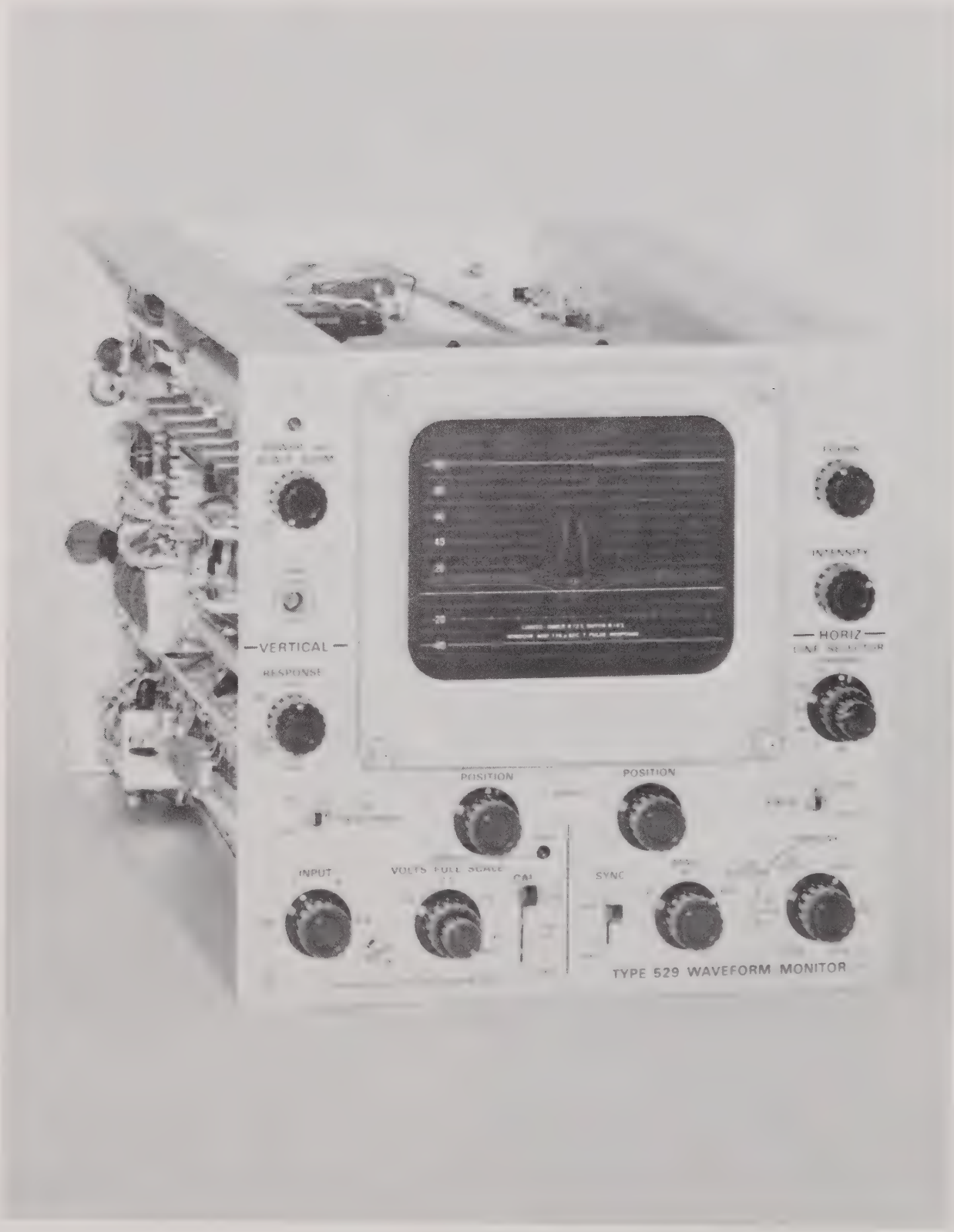

Fig. 1-1. Type 529 Waveform Monitor.

SECTION 1

CHARACTERISTICS

General Information

The Tektronix Type 529 Waveform Monitor is a self-contained cathode-ray oscilloscope specifically designed for video-waveform monitoring at television transmitters and studio facilities. With this monitor, any portion of the television-signal waveform can be displayed on a 5-inch rectangular cathode-ray tube.

A frequency-response switch is included which enables the selection of several frequency-response characteristics including that characteristic recommended by the IEEE Standards Committee for standardized pulse-level measurements.

An internal 30-kHz amplitude calibrator provides 0.714-volt or 1.0-volt pulses for calibrating the vertical amplifier. The sweep system provides calibrated sweeps which eliminate the need for time markers.

The following characteristics apply over an ambient temperature range of 0° C to 50° C. Warm-up time for the given accuracies is 20 minutes at 25° C, ±5° C.

Performance requirements throughout this manual are stated in either percentage or IEEE units. The compatible dB point is also inserted using the formula:

$$dB = 20 \log \frac{V1}{V2}$$

VERTICAL DEFLECTION SYSTEM

Characteristic	Performance Requirement	Supplement Information
Frequency Response FLAT (1 V gain sensitivity)	Flat to within +0%, —1% (0.1 dB) from 50 Hz to 6 MHz. Flat to within +0%, —3% (0.3 dB) from 6 MHz to 8 MHz.	
FLAT (0.2 and 0.5 V gain sensitivities) LOW PASS HIGH PASS IEEE	Flat to within +0%, —1% (0.1 dB) from 50 Hz to 6 MHz. Down not less than 80% (14 dB) at 500 kHz or above. 3.58 MHz center frequency 15 to 35% down in amplitude to + and — 400 kHz. See Fig. 1-2.	
Transient Response High Frequency	T/2 pulse must be between 94 and 100 IEEE units high for 100 IEEE units of bar signal amplitude applied and have less than or equal to 3 IEEE units of overshoot.	Any ringing as observed on the test oscilloscope (Type 547 with 1A1 plug-in used for check) must be added to the overshoot tolerance.
Middle Frequency	Top of bar signal must be flat within ±½ IEEE unit.	Flatness measured at +100 IEEE unit graticule line.
Gain Sensitivity	1 V—Adjustable to 1 V. 0.2 V—Adjustable to 0.2 V. 0.5 V—Less than ±3% error.	
Variable Gain Sensitivity	Must attenuate the gain by a ratio of at least 2.5:1.	Ratio of maximum amplitude to minimum amplitude.

HORIZONTAL DEFLECTION SYSTEM

Calibrated Sweep Rates × 1 × 5 × 25	 Adjustable to 0.125 H/cm. Should be within ±3% of 0.025 H/cm. Should be within ±3% of 0.005 H/cm.	
Staircase (RGB-BW) Relay	When relay K501 is energized, sweep will be at either line or field rate (depends on DISPLAY switch setting), and 2.5 cm or less in length.	
Line Selector (Variable) Minimum Delay	 Line selection will start on or before the 15th line of either field.	
Discrete Line Selector (SN 998-up)	Sweep will start on the line indicated by the LINE SELECTOR (switch) position on both fields.	

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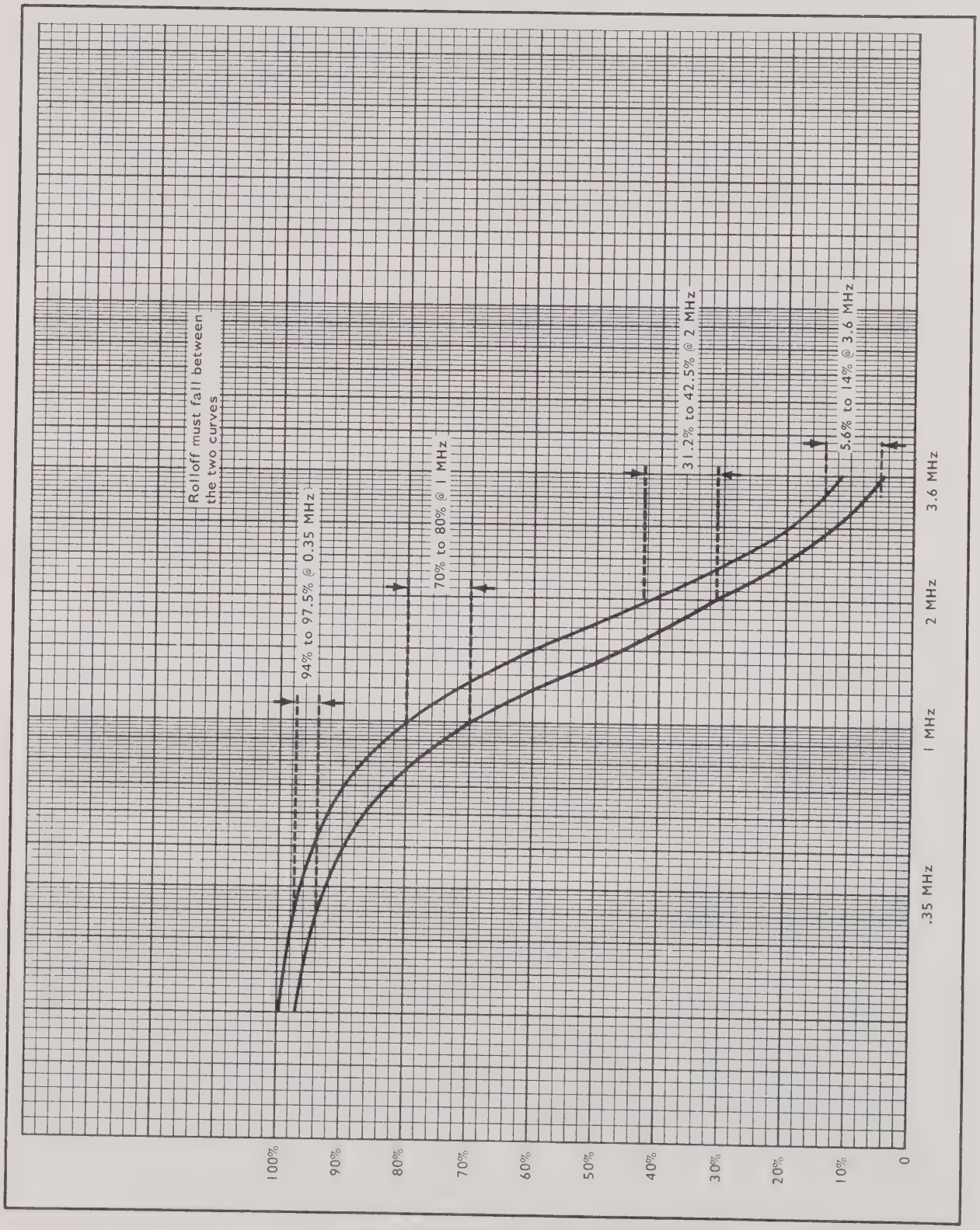

Fig. 1-2. IEEE 1958 standard 23S-1.

Characteristics	Performance Requirement	Supplemental Information
Field Selector		
ONE	Sweep is triggered by field one.	
TWO	Sweep is triggered by field two.	
TRIGGERING		
External Trigger	Stable triggering must be obtained on an input composite video signal $\leq$ 250 mV to $\geq$ 1 V in amplitude.	
Internal Trigger	Stable triggering must be obtained on an input composite video signal $\leq$ 200 mV to $\geq$ 1 V in amplitude.	
AMPLITUDE CALIBRATOR		
Signal Accuracy		
.714 FS	Adjustable to 0.714 V	
FULL SCALE	Within $\pm$1% of 1 V	
Frequency		Approximately 30 kHz.
POWER SUPPLY		
Power Source	115 Vac, $\pm$10%, 50 to 60 Hz.	Can be connected for 230-VAC operation.
Power Source Fuse	Type 3 AG, 1.25 A slow-blowing.	Type 3 AG, 0.6 A slow-blowing for 230-Vac operation.

CATHODE-RAY TUBE

Characteristics	Information
Tube Type	T5290-31 rectangular, glass envelope (SN100-2929). T5291-31 (SN2930-up).
Phosphor	P31 standard. Others available on special order.
Accelerating Potential	Approximately 5300 V.
Graticule Type	External. See Standard Accessories list for graticules.
Scan Area	The equivalent of 7 or more centimeters of vertical area and the equivalent of 10 or more centimeters of horizontal area.
Graticule Illumination	Variable edge lighting.
Unblanking	DC used on all sweep rates with AC coupled brighting pulses for line Selector modes of operation.
CRT Beam Rotator	Electrical. Will vary the beam across horizontal by 1° in either direction (total range is equal to or greater than 6°).

MECHANICAL CHARACTERISTICS

Characteristics	Information
Contruction	Aluminum-alloy chassis and panel.
Finish	Anodized panel.
Overall Dimensions (measured at maximum points)	8¼ inches high, 8½ inches wide, 19 5/16 inches long (includes rear feet and front panel knobs).

Standard Accessories

Information on accessories for use with this instrument is included at the rear of the mechanical parts list.

NOTES

SECTION 2

OPERATING INSTRUCTIONS

General

This section of the manual provides general operating information. Included is a brief description of the Type 529 controls and a suggested first-time operating procedure.

Power Requirements

The regulated power supplies in the Type 529 will operate with line voltages from 103.5 to 126.5 Vac (115 Vac, ±10%) or from 207 to 253 Vac (230 Vac, ±10%). The line-voltage operating range for which your instrument is wired at the factory is indicated on a metal tag fastened to the rear panel near the power receptacle.

The power transformer is wound with two 115-volt primaries which are connected in parallel for 115-volt operation and in series for 230-volt operation. Fig. 2-1 shows the connections for both voltages. When the transformer connections are changed, the metal tag should be turned around so the back side becomes the front. The unmarked side can then be marked with a pencil for the new operating voltage.

For maximum dependability and long life, the line voltage applied to the Type 529 should be near the voltage indicated on the tag. If the line voltage exceeds the operating limits, or has a poor waveform (distorted sine waves), unstable power-supply operation may result. Check for proper line voltage and waveform before checking for other causes of unstable operation.

Cooling

The Type 529 is cooled by convection air flow through the instrument. If possible, allow two inches clearance at the sides and rear of the instrument for proper air circulation. Temperature of the circulating air should not exceed 50° C (122°F) for safe operation.

Installing the Type 529

The Type 529 is designed to be cradle-mounted in a standard 19-inch rack or console side by side with another Type 529, or with a commercial 8-inch picture monitor. Provisions should be made for cool air inlet and power- and signal-cable connections at the rear of the instrument.

Dimensions of the Type 529 are shown in Fig. 2-2 (a) and (b). The cradle mount which holds a commercial 8-inch picture monitor is used to hold the Type 529. Four threaded 8-32 holes are provided in the bottom of the Type 529 so the instrument may be securely fastened to the cradle-mount shelf. These same holes may be used to fasten the field case to the instrument. Fig. 2-2 (c) shows the hole location requirements for the cradle-mount shelf.

Two special cradle assemblies are available as optional accessories for use with the Type 529. These assemblies provide (a) one Type 529 mounted on the left side of the monitor; and (b) one Type 529 mounted on the right side of the monitor. See your local Tektronix representative before ordering.

The Type 529 may be removed from the console and slipped into a field case for portable use. The field case is available as an optional item. The dimensions of the case are $9^{15}/_{16}$ inches high, $8^{7}/_{8}$ inches wide, and $17^{13}/_{16}$ inches deep (overall).

FUNCTION OF FRONT-PANEL CONTROLS AND CONNECTORS

VERTICAL Controls

INPUT

Four-position switch to select one of four input signals: internal calibrator, input A, input B or A-B differential.

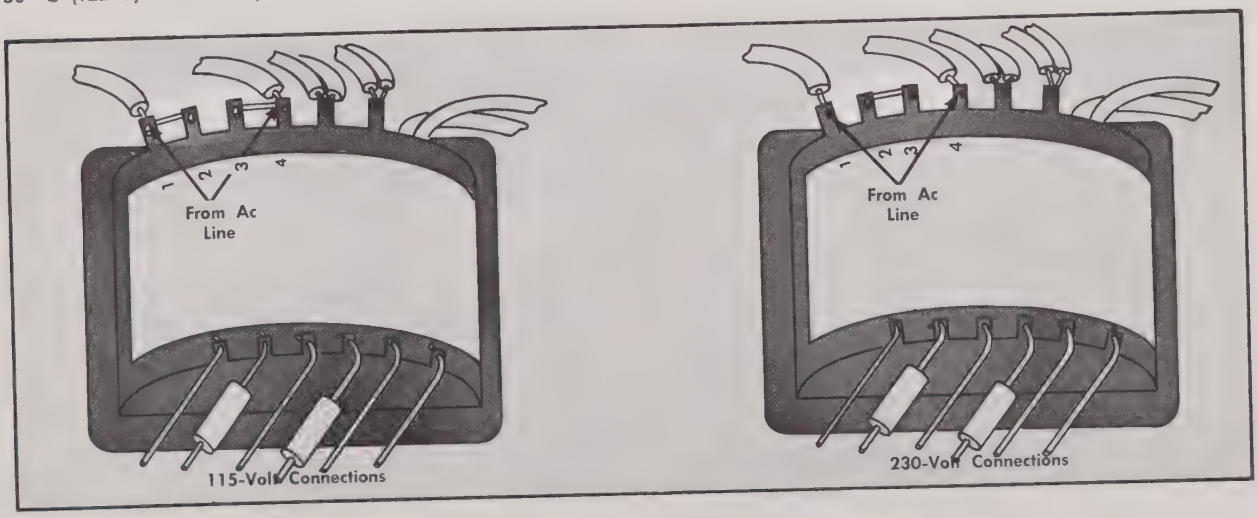

Fig. 2-1. Power transformer connections for 115- and 230-volt operation.

Ⓐ1

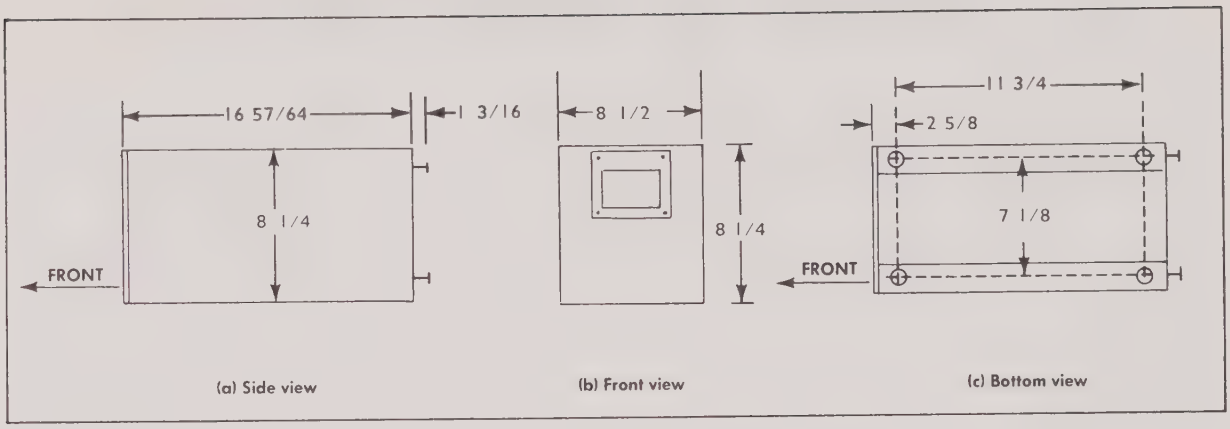

Fig. 2-2. Type 529 approximate dimensions and location of mounting holes.

POSITION

Positions the trace vertically on the crt.

RESPONSE

Four-position switch to select the amplifier frequency-response characteristics as listed in Section 1 of this manual.

VOLTS FULL SCALE

Three-position switch to select the calibrated vertical gain settings of 1.0, 0.5 and 0.2.

VARIABLE (VOLTS FULL SCALE)

Continuously variable control with a minimum range of 4 to 1 to permit variable adjustment of gain between VOLTS FULL SCALE switch settings. When the VARIABLE control is set to CALIB, the CALIB neon turns on to provide a visual indication that this is the calibrated gain setting.

GAIN Adjustment

A screwdriver adjustment to reset the overall calibration of the instrument. (Corrects for long-term change in the high-voltage supply, which has the greatest effect on overall calibration of the instrument.)

DC RESTORER

Two-position lever switch for turning the Dc Restorer circuit off and on. This circuit is not a signal clamp. Instead, it is a keyed Dc Restorer circuit which stabilizes the blanking pulse back porch at a constant level on the crt, despite changes in signal amplitude or average luminance. The dc-restoration time constant is sufficiently long so that hum and tilt in the video signal will be displayed. This circuit eliminates dc drift of the vertical amplifier, making it unusually stable. There is no distortion, clipping, or degradation of the color-burst signal. The presence of the color burst does not cause the base line to shift.

CAL

Three-position lever switch that selects either 140 or 100 IEEE units of signal according to the graticule markings, or selects an external calibration signal.

POWER and SCALE ILLUM

Control for turning the instrument power on and off, and for varying the illumination of the graticule markings.

FOCUS

Permits adjusting the beam to obtain a well-defined display.

INTENSITY

Controls brightness of the display.

HORIZ Controls

POSITION

A ten-turn control to position the display horizontally.

DISPLAY

A six-position switch to select 2 fields or 2 lines of video signal, 0.125 H/cm, 0.25 H/cm, line selector 0.125 H/cm or line selector 0.25 H/cm.

The 2 FIELD or 2 LINE positions of the DISPLAY switch are used for general waveform monitoring. When the DISPLAY switch is set to 2 FIELD, the sweep operates at the frame rate, displaying about 2 fields. The FIELD lever is used in conjunction with the 2 FIELD position to allow display of either field 1 or field 2. When the DISPLAY switch is set to 2 LINE, the sweep operates at one-third of the line rate, displaying about 2 lines.

NOTE

The 2 FIELD position is the only position of the DISPLAY switch where a free-running trace can be obtained in the absence of a trigger signal. Thus, the 2 FIELD position is useful for determining whether the video signal is absent.

When the DISPLAY switch is set to .125 H/CM, horizontal sync timing is measured in terms of H (the time between horizontal sync pulses, or the time from the start of one horizontal line to the start of the next line). When the (HORIZ) MAG switch is set to ×1, one complete horizontal line is displayed in a sweep length of 8 cm (see Fig. 2-3a). In addition, refer to Table 2-1 which lists the sweep-time relationship between H/cm and μs/cm.

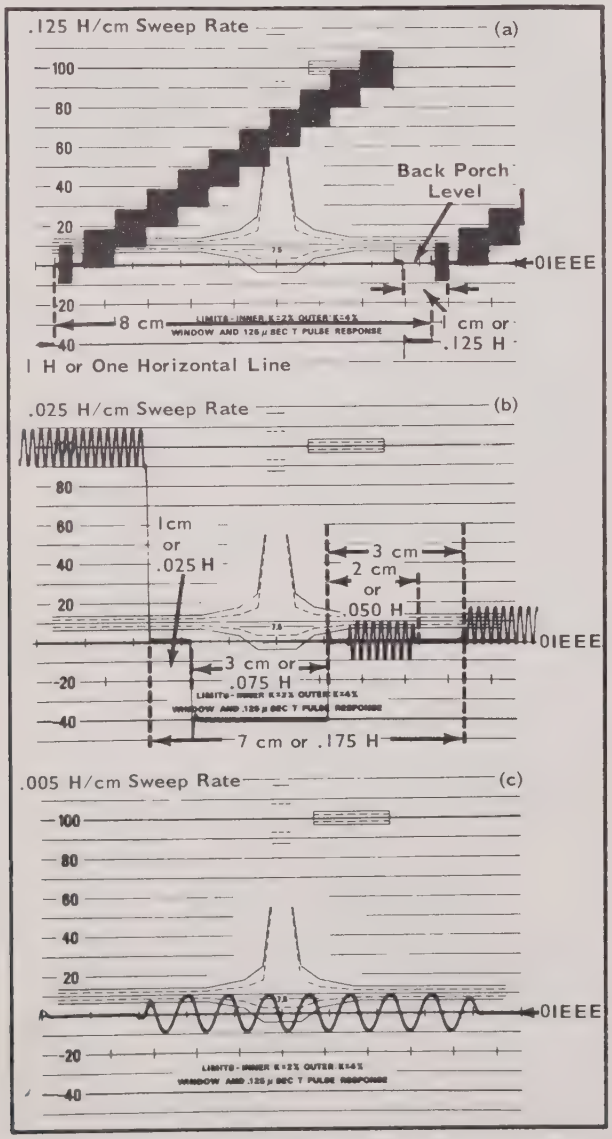

Fig. 2-3. Using the .125 H/CM position of the DISPLAY switch, in conjunction with the MAG switch, to make horizontal line sync pulse measurements. (a) MAG switch set to ×1 or 0.125 H/CM sweep rate, (b) MAG switch set to ×5 or 0.025 H/CM, and (c) MAG switch set to ×25 or 0.005 H/CM sweep rate.

TABLE 2-1

(HORIZONTAL) MAG	DISPLAY Switch Setting	
	.125 H/CM[1]	.250 H/CM[1]
×1	0.125 H/cm	0.250 H/cm
	7.94 μs/cm	15.9 μs/cm
×5	0.025 H/cm	0.05 H/cm
	1.59 μs/cm	3.18 μs/cm
×25	0.005 H/cm	0.01 H/cm
	0.318 μs/cm	0.635 μs/cm

[1]**Also applies to the LINE SELECTOR settings of the DISPLAY switch.**

For pulse measurements at .125 H/CM, one cm equals 0.125 H. For example, in the NTSC (National Television Standards Commission) signal specifications, 0.125 H is the minimum time interval between the leading edge of the horizontal sync pulse and the end of the color burst.

If the (HORIZ) MAG switch is set to ×5 when the DISPLAY switch is at .125 H/CM, the time-base sweep rate is 0.025 H/cm. This sweep rate is used, for example, to make horizontal sync-pulse waveform measurements such as those shown in Fig. 2-3b.

If the (HORIZ) MAG switch is set to ×25 when the DISPLAY switch is at the .125 H/CM position, the sweep rate is 0.005 H/cm. This sweep rate is useful for measuring the risetime and falltime of the horizontal sync pulses, to count the cycles of color burst (see Fig. 2-3c) and to examine portions of a complete line.

The .25 H/CM position of the DISPLAY switch is another calibrated sweep rate which is useful for making horizontal line- and sync-pulse waveform measurements. In the ×1 position of the (HORIZ) MAG switch approximately 2½ horizontal lines are displayed. Table 2-1 lists the sweep-time relationship between H/cm and μs/cm for each MAG switch position.

When the DISPLAY switch is set to either of the LINE SELECTOR positions and the LINE SELECTOR control is used, it is possible to range into the top of the picture to examine any one or two lines, depending on whether the DISPLAY switch is set to the .125 H/CM LINE SELECTOR or .25 H/CM LINE SELECTOR position. Also, the LINE SELECTOR control can be set so the portion of the vertical blanking pulse which may contain vertical-interfield test signals can be examined in detail. The .25 H/CM LINE SELECTOR position, in particular, is useful for observing $\sin^2$ pulses.

The range of the LINE SELECTOR control is such that any portion of field 1 or field 2 can be examined. Either field 1 or field 2 is selected by means of the FIELD switch. A special bright-up circuit in the Type 529 increases the crt writing rate in either of the two LINE SELECTOR positions.

MAG

Three-position switch to select sweep magnification ratios of ×1, ×5, and ×25 for all positions of the DISPLAY switch.

LINE SELECTOR

Ten-turn variable control (and a seven position switch SN 998-up) for starting the sweep at the beginning of any

selected line in the field so that a particular line can be examined in detail. Used in conjunction with all positions of the (HORIZ) MAG and FIELD switches when the DISPLAY switch is set to LINE SELECTOR .125 H/CM or .25 H/CM.

FIELD

Two-position lever switch to select either field 1 or field 2. Used in conjunction with the LINE SELECTOR and 2 FIELD positions of the DISPLAY switch.

SYNC

Two-position lever switch to select either internal or external sync sources.

REAR-PANEL CABLE CONNECTIONS

VIDEO INPUTS A, VIDEO INPUTS B

Two pairs of signal-input coaxial connectors are provided. These are VIDEO INPUTS A and VIDEO INPUTS B. These video inputs are designed for high-impedance loop-through, compensated for 75-ohm systems. Bridging capacitance is approximately 20 pF.

If the second connector of each pair is not used, it can either remain unused if the line is terminated elsewhere, or it can be used for terminating the line with a 75-ohm termination if the line is **not** terminated elsewhere.

EXT NEG SYNC INPUT

A pair of coaxial connectors marked EXT NEG SYNC INPUT is provided on the rear panel to couple external sync signals to the Type 529. This input is a high-impedance loop-through connector and is compensated for 75-ohm systems. Bridging capacitance is about 20 pF. To select external sync, set the SYNC switch to the EXT position.

EXT CAL INPUT

The pair of connectors marked EXT CAL INPUT, located on the rear panel, is provided to couple external calibration signals to the instrument. The connectors are connected in parallel to couple the signal in and out of the instrument. To select the external calibration signal, set the INPUT switch to CAL and the CAL switch to EXT.

VIDEO OUTPUT

A single VIDEO OUTPUT connector is provided for driving a picture or line monitor. It is important that the VIDEO OUTPUT connector be terminated into 75 Ω to ensure correct frequency response of the vertical amplifier. The signal available at this connector, when properly terminated, is approximetely the same amplitude as the signal applied to the Type 529.

Added to the VIDEO OUTPUT signal is a line intensifying pulse. This pulse is approximately 0.1 volt in amplitude or about 10% of the VIDEO OUTPUT signal when the input video signal is 1 volt.

The line intensifying pulse is generated only when the DISPLAY switch is set to LINE SELECTOR .125 H/CM or LINE SELECTOR .25 H/CM. The LINE SELECTOR control is used to select the line(s) to be examined in detail on the Type 529 crt and the picture monitor. The line intensifying pulse brightens the selected line(s) on the picture monitor for easy identification.

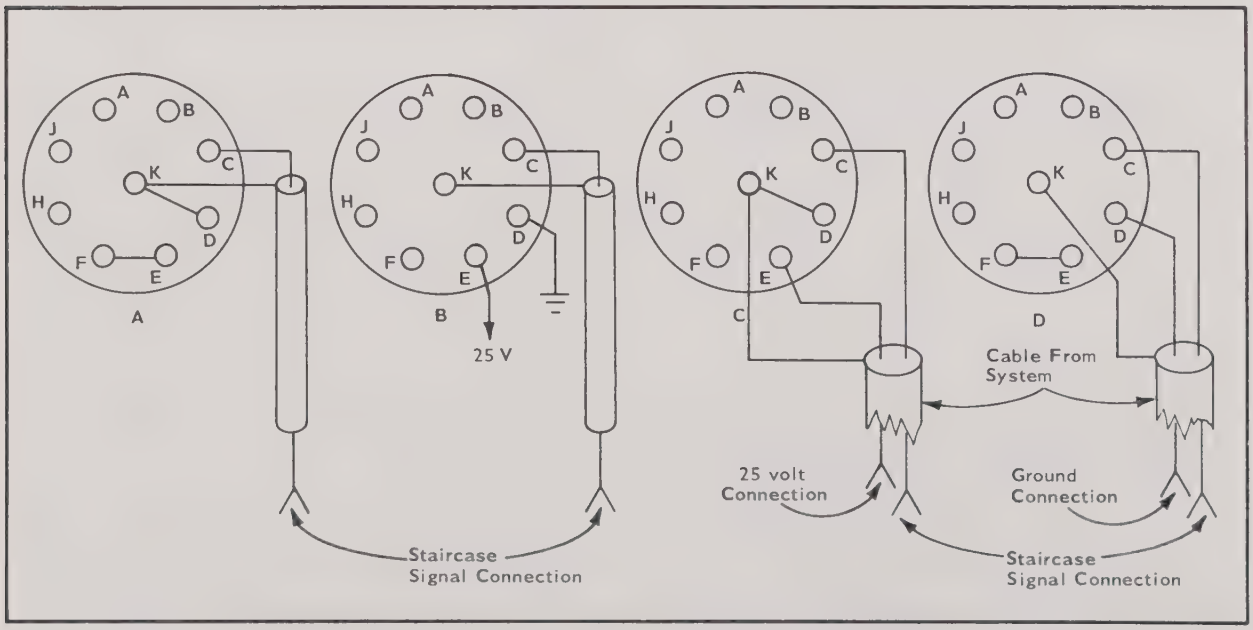

Fig. 2-4. Front view of 9-pin plug connector (Tektronix Part No. 134-0049-00) showing jumper wire connections to; (a) Cause relay K501 to be energized whenever the plug is in place. (b) Energize the relay when an external voltage and ground connection are used. (c) Energize the relay when a GE system is connected. (d) Energize the relay when a RCA system is connected.

J501 Connector

A 9-pin female connector (J501) is provided to connect an external staircase signal to the Type 529. Fig. 2-4 shows how to connect the signal and remotely actuate relay K501.

When K501 is actuated and the DISPLAY switch is set to any position, the sweep length is reduced to about 2½ cm. Thus, when a 20-Hz staircase signal of correct amplitude (about 12-volts overall amplitude) is applied through pin C of J501, the display is positioned in accordance with the staircase output from a color processor.

FIRST-TIME OPERATION

NOTE

It is necessary to check and adjust the VERT GAIN control (internal adjustment) each time the type of graticule is changed.

To place the instrument in operation for the first time, the following procedure is suggested:

1. Connect the instrument to a source of power specified by the metal tag located near the power connector.

2. Set the front-panel controls as follows:

POWER and SCALE ILLUM	⅔ clockwise
FOCUS	Centered
INTENSITY	⅔ rotation clockwise

VERTICAL Controls

INPUT	CAL
POSITION	Centered
RESPONSE	FLAT
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
DC RESTORER	ON
CAL	FULL SCALE

HORIZ Controls

POSITION	Centered (five full turns from either end)
DISPLAY	2 LINE
MAG	×1
LINE SELECTOR	As is
FIELD	One or Two
SYNC	INT

3. After the instrument has warmed up for a few minutes, adjust the INTENSITY control for adequate brightness of the square-wave calibrator waveform.

4. Adjust the (VERTICAL) POSITION control to center the display.

5. Adjust the FOCUS control to obtain a sharply defined display.

6. To observe other waveforms, connect a video signal to either the VIDEO INPUTS A or B connector and set the INPUT switch to the appropriate position.

To observe an external calibration waveform, connect the calibration signal from the external source to the EXT CAL connector. Place the INPUT switch to CAL and set the CAL switch to EXT.

Crt Beam Rotator

If the trace does not coincide with the graticule lines, the CRT BEAM ROTATOR (R655) needs to be adjusted. To adjust the control, proceed as follows:

1. Perform steps 1 through 5 in the First-Time Operation procedure.

2. Set the CAL switch to .714 F.S., and the DISPLAY switch to 2 FIELD.

3. Adjust the CRT BEAM ROTATOR control so the bottom trace of the calibrator pulses coincides with the O IEEE graticule line. Location of the control can be found by referring to Fig. 6-7 in the Calibration section of this manual.

GAIN Adjustment

A front-panel GAIN screwdriver adjustment is provided to correct for long-term change in the high-voltage supply. A change in the supply voltage will affect both the vertical and horizontal calibration.

To check calibration, check the vertical-amplifier calibration first as follows:

1. Perform steps 1 through 5 in the First-Time Operation procedure.

2. Check that vertical deflection is 140 IEEE units. If the deflection is not 140 IEEE units, adjust the GAIN control to obtain proper deflection.

3. If desired, the horizontal calibration can be checked by performing steps 16-19 in the Calibration section of this manual. If the HORIZ GAIN R568 or C481 are adjusted, then steps 18 and 19 should also be performed to fully calibrate the horizontal sweep rates.

MODIFICATIONS

Introduction

Four modifications are available to make the Type 529 satisfy certain studio conditions. The first three can be made in the field, but the last one is more complex and, therefore, is normally done at the factory.

1. Changing to Sync-Tip Restoration

To change the Type 529 circuitry so sync-tip restoration can be used instead of back-porch clamping.

a. Unsolder the yellow-on-white wire (refer to Fig. 2-5) and R289 from the INPUT switch contact. Leave the wire and resistor leads connected together.

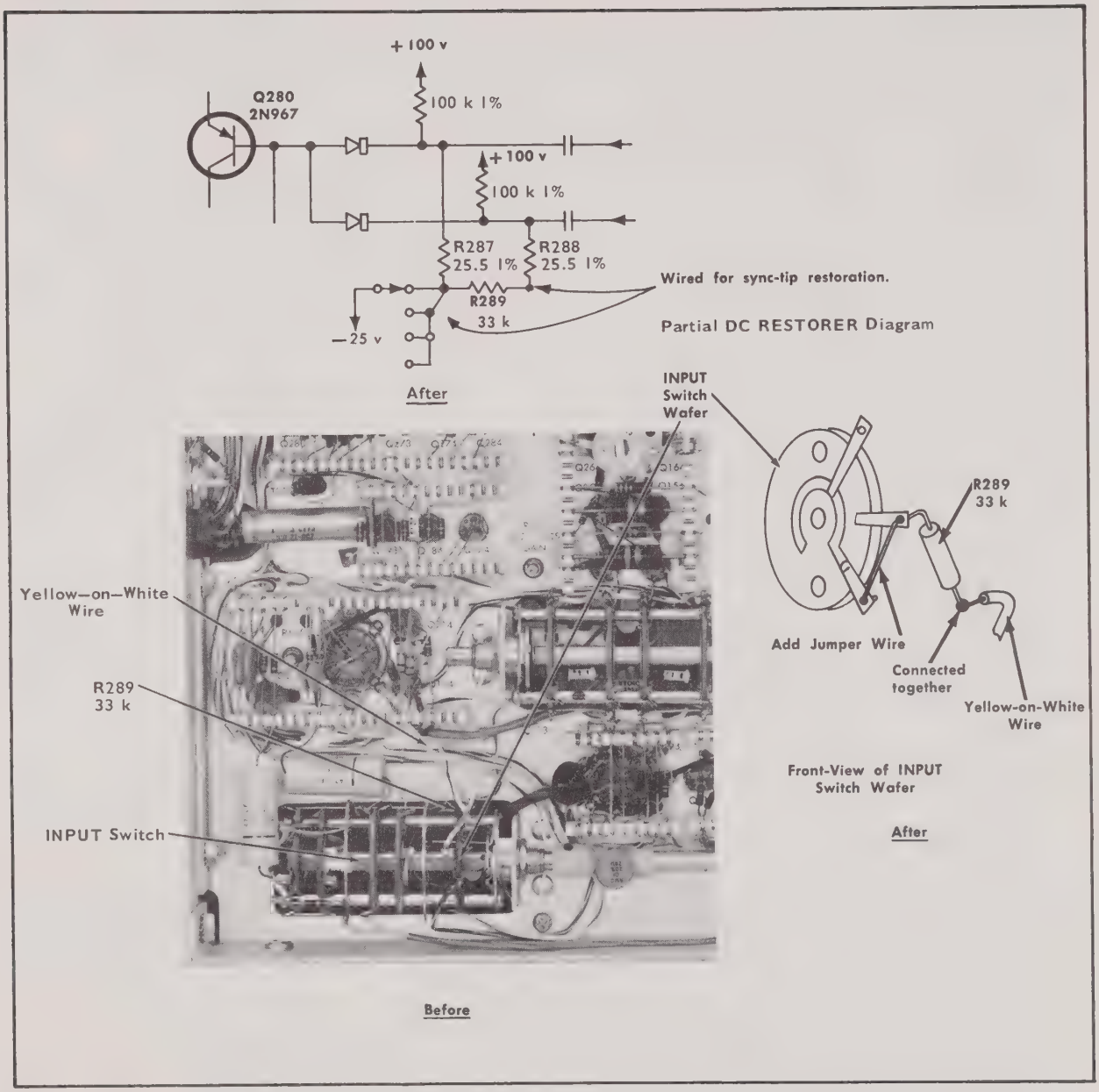

Fig. 2-5. Modification for sync-tip restoration.

b. Solder a jumper wire between the two contacts on wafer IF of the INPUT switch as shown in Fig. 2-5.

2. Changing to DC Input Coupling

Sometimes it is necessary to observe the demodulated output from a television transmitter using a dc-coupled oscilloscope. For this purpose the Type 529 can be dc coupled, using VIDEO INPUTS A, as follows:

a. Refer to the Vertical Amplifier diagram at the back of this manual and the partial diagram shown in Fig. 2-6.

b. Remove C104 and C204 and solder jumper wires in their place.

c. Disconnect the ground lead that connects from the J201/J202 connector outer conductor to the INPUT switch contact.

d. Remove R201 from its location on the INPUT switch. Connect R201 between J201/J202 connector outer conductor and ground.

e. Connect one of the removed capacitors between J201/J202 connector outer conductor and the INPUT switch contact (where one end of R201 was formerly connected).

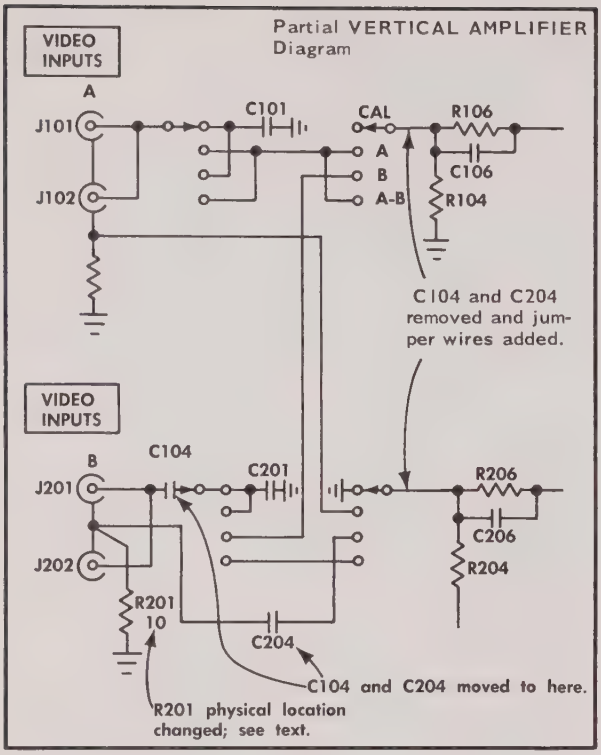

Fig. 2-6. Modification to dc couple VIDEO INPUTS A.

f. Locate the jumper wire going from J201 connector center conductor to the INPUT switch contact. Disconnect this Jumper at J201 and cut off about 2 inches to shorten it. Connect the second capacitor in series between the shortened end of the jumper lead and the center conductor of J201.

NOTE

After completing this modification, the DC RESTORER is automatically off when the INPUT switch is set to A.

3. Changing the Sweep Repetition Rate

Since the field rate in some countries differs from the 30-Hz rate used in the United States, the Type 529 must be modified to operate at the different rate.

To modify the instrument to operate at a longer time per field (slower sweep-repetition rate) than 30 Hz, increase the value of C483. For less time per field (faster sweep-repetition rate), decrease the value of C483 by substituting a smaller value. Refer to the base circuit of Q483 on the Sweep Generator diagram at the back of the manual to locate C483 on the diagram.

4. Changing to 4.4-MHz Chroma Response

In countries using a 4.4-MHz color-burst frequency, the Type 529 must be modified and adjusted to pass this center frequency when the RESPONSE switch is set to HIGH PASS. This modification is much more complex and is, therefore, normally performed in the factory at the request of the purchaser at the time the instrument is ordered.

When the factory modification is made, prepared insert sheets showing the changes are inserted in the manuals accompanying the modified instrument. For this reason, no further information is provided in this section of the manual.

NOTES

SECTION 3

CIRCUIT DESCRIPTION

General Information

The Type 529 Waveform Monitor circuits contain both vacuum tubes and transistors. Portions of both the vertical and horizontal systems contain amplifiers with special feedback for gain stability independent of tubes or transistors. Several multivibrators in the trigger and horizontal systems provide precise display triggering. Refer to the block and circuit diagrams at the back of this manual during the following circuit descriptions.

All connectors are rear-panel mounted. Four of the input circuits are 75-ohm coaxial loop-through; two VIDEO INPUTS, EXT NEG SYNC INPUT and EXT CAL INPUT. The Staircase Input (J501) is a special nine-pin socket (see Staircase Input discussion in Section 2 for mating connector). The VIDEO OUTPUT coaxial Jack has a 75-ohm unbalanced output impedance.

BLOCK DIAGRAM

The (VERTICAL) INPUT switch selects either of two video signals, or the A signal minus the B signal, or the CAL signal, (the calibrator signal can be from an external source) and applies it to the input of the Preamplifier. The Preamplifier and Magnifier supplies the signal to both the Response Filters and the Sync Amplifier. The Response Filter passes the signal on to the Output Amplifier and to the crt deflection plates. The Output Amplifier also supplies the signal to the Keyed Dc Restorer circuit. The Sync Amplifier supplies an ac-coupled signal to the VIDEO OUTPUT jack (with an open circuit gain of 2, and 75-ohm loaded gain of 1 referred to the video input), and an ac-coupled signal to the Sync Separator.

The Sync Separator regenerates the horizontal sync pulses so their shape and amplitude is always the same. Plus and minus regenerated horizontal sync pulses are available for operating the Keyed Dc Restorer circuit. Minus H pulses are used when displaying video, and plus H pulses are used when displaying the Calibrator.

The Keyed Dc Restorer circuit holds the display steady at the video back-porch level or the negative level of the internal calibrator. The circuit operates by controlling the dc level of the Preamplifier and Magnifier minus input. The video input signals are ac coupled, but the Preamplifier and Magnifier, Response Filters, and Output Amplifier are dc coupled. The dc-restorer circuit virtually eliminates display shift with change in signal amplitude, but response time is slow enough for hum or tilt to be observed.

The Sync Separator —H signal is used by the Trigger Selector Matrix when the display is of a line nature (undelayed). The +H signal does not go directly to the Trigger Selector Matrix, but to the Vertical Sync Separator, and then to both the Field 1 Recognition circuit and the Field Trigger Generator (Q375-Q385). The Field Trigger Generator triggers the Sweep Gating Multivibrator via the Trigger Selector Matrix for field displays (undelayed), and triggers the Sweep Gating Multivibrator through the Delay Generator and Trigger Selector Matrix for delayed field displays.

The Sweep Gating Multivibrator and Sweep Generator triggering source and sweep rate is set by the front-panel DISPLAY switch. Triggers are received by the Sweep Gating Multivibrator that allows the Sweep Generator to run and drives the Unblanking Amplifier to turn on the crt beam at the time of the sweep. The Unblanking Amplifier also sends a brightening pulse to the crt and the VIDEO OUTPUT jack during delayed line modes. The Sweep Generator drives both the Horizontal Amplifier and the Staircase Amplifier. The Staircase Amplifier is inserted between the Sweep Generator and the Horizontal Amplifier when external control (through J501) switches the Sweep Generator function to read the red, blue, green and black-white portions of a color studio camera.

The High Voltage Supply contains the crt high-voltage power supply. A portion of the power-supply circuit forms the calibrator signal at the ≈30 kHz rate of the high-voltage oscillator. An external calibrator signal can be substituted for the internal signal.

VERTICAL AMPLIFIER

The video input circuits of the Vertical Amplifier are shown in simplified form in Fig. 3-1. The 10-ohm resistor in Fig. 3-1A is optional, but necessary in the event there is any ac potential difference between the input coaxial cable and the Type 529 chassis. It presents any cable-to-chassis signal differentially to the Vertical Amplifier so the signal will not become part of the display. (Any signal on the outside of the braid of a coaxial cable is also on the center conductor, but with the same polarity. The equal signals are applied to the + and — input terminals, and cancelled by the differential rejection characteristics of the Vertical Amplifier.) The A-B input of Fig. 3-1B does not use the 10-ohm resistors because the cables are likely to have the same unwanted information. Since the unwanted information appears on both center conductors, it is presented to the Vertical Amplifier in differential form and cancelled.

Operating With The DC Restorer Circuit Off

Operation of the Vertical Amplifier will be described first with the DC Restorer circuit turned off.

Both the + and — input grids of V113 see 1 megohm return to ground. The input signals are AC coupled to the input grids through C104 and C204. The rest of the Vertical Amplifier is DC coupled.

Preamplifier. The Preamplifier consists of two input cathode followers (V113A and V113B), and a two-transistor amplifier Q114 and Q214. The Preamplifier is shown in simplified form in Fig. 3-2A. The cathodes of V113 return to the same constant-current circuit to which the emitters of Q114-Q214 return. The VOLTS FULL SCALE control between emitters of Q114-Q214 couples the signal between emitters, causing both sides of the amplifier to have an output signal when only one input receives a signal.

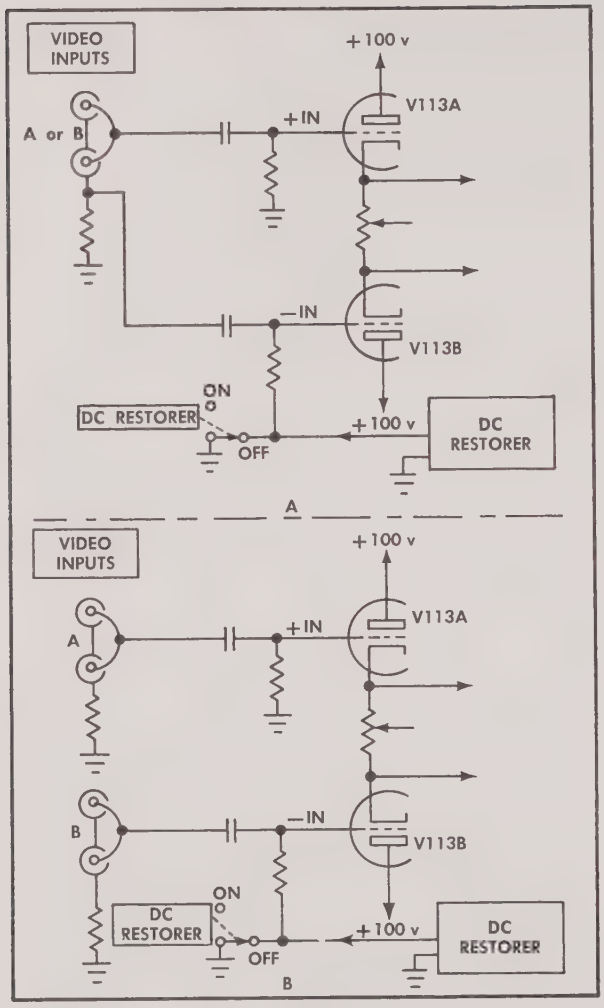

Fig. 3-1. Simplified Vertical Amplifier input circuits.

The tubes serve basically as impedance transformers, changing the 1-megohm input resistance to about 400 ohms to drive each transistor base. The cathode-return resistors have a value about 20 times the cathode-follower output impedance, therefore, do not attenuate the signal significantly. Each cathode follower passes about 93% of the input signal to the following transistor base.

The emitter resistors would normally be very degenerative, and would thus keep the stage gain very low. However, the VOLTS FULL SCALE resistance between the two emitters also couples the signal from one side to the other. Fig. 3-2B shows a simplified concept of the VOLTS FULL SCALE control signal path. If, in this theoretical circuit, the VOLTS FULL SCALE resistor were made zero ohms, the input signal to one transistor base would divide equally between the two halves of the stage. Fig. 3-2B shows the internal emitter resistances in series. Thus, VOLTS FULL SCALE equal to zero ohms degeneration on one side of the amplifier is the emitter resistance of the other side. This causes both sides of the amplifier to have gain. The emitter return resistors are many times greater than the emitter internal resistance, and, therefore, do not attenuate the signal when the VOLTS FULL SCALE resistance is low. The actual minimum VOLTS FULL SCALE resistance is about 590 to 600 ohms between emitters setting the push-pull output signal equal to about 2 times the single-ended input signal.

A typical single input signal will cause the following action (assume the VOLTS FULL SCALE resistance to be 600 ohms): Q114 base is driven in the positive direction 1 volt and its emitter follows it nearly 1 volt. The 600-ohm resistor allows the emitter current to increase and the emitter voltage to follow the base voltage nearly one volt. The increased forward bias of Q114 is about 0.02 volt. The signal current is essentially 1.66 mA greater than the static current. The only source for the signal current is the emitter of Q214; therefore, both transistors receive the same amount of signal current (but of opposite polarity) for a single input signal. The result is that both 649-ohm collector resistors have a 1.66 mA signal current. The collector of Q114 goes negative, and the collector of Q214 goes positive producing a push-pull output signal about 2.2 volts peak to peak. Since the collector load resistors have equal and opposite current

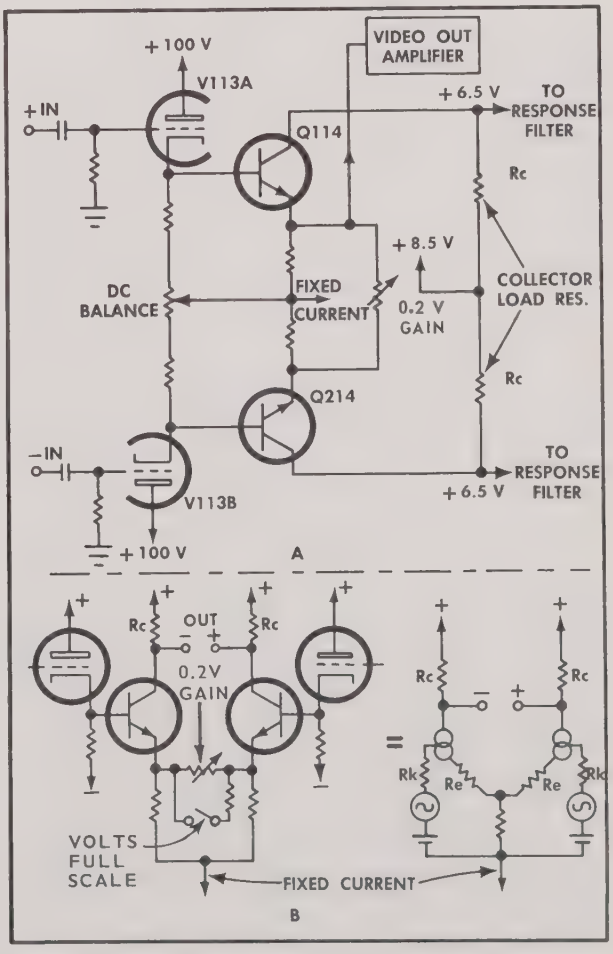

Fig. 3-2. Simplified circuit.

changes, the voltage at their center does not change. A common-mode signal reaching the Preamplifier would change the voltage at the junction of the collector load resistors, and degrade the common-mode rejection of the amplifier except for presence of the Constant Current Stage.

The high-frequency gain of the Preamplifier is adjusted to equal the low-frequency gain by making the rc time constant of the emitter circuit equal to the rc time constant of the collector circuit. The cathode followers' output impedance allows the Miller capacitance of the transistors to affect the high-frequency response. To minimize the Miller effect, the transistor stage is neutralized by C113 and C213. The variable capacitors (C118B and C118C) across the VOLTS FULL SCALE resistors R118B and R118C permit the Preamplifier frequency response to be properly adjusted. There is no need for a variable capacitor across R118A, due to wiring stray capacitance.

In the event of minor differences in bias of the input cathode followers, (and the resultant output voltage difference) the DC BAL control (R115) is set to create a compensating change in current in the cathode return circuit. The DC BAL control final setting is correct if the trace does not shift when changing the VOLTS FULL SCALE switch position (with the DC RESTORER OFF).

The high impedance of the Preamplifier transistor collectors allows the output voltage to be varied a slight amount without significant change in current. The VAR DC BAL control slightly alters the voltage balance of the Preamplifier output to allow the Output Amplifier VARIABLE control (between emitters of Q144-Q244) to be adjusted without shifting the trace position.

Constant Current Stage. The Constant Current stage cancels any push-pull output from the Preamplifier in the event both input leads receive equal amplitude—equal polarity signals. The circuit causes the voltage of the constant current leads of Fig. 3-2 to shift and follow any common-mode input voltages. (The high collector resistance of Q114 and Q214 prevents any change in the Preamplifier output voltage.) Fig. 3-3 shows simplified connections between the Constant Current stage and the Preamplifier. Assume both input leads to be positive. The result is that both collector-load resistors receive an increase in current. The increased current pulls down on R121. R122 divides the change to the base of Q124. Q124 base goes negative and causes its collector to go positive an amount equal to the original common-mode signal. This cancels its effect and returns the current in the collector-load resistors to the original value. The cathode followers' negative supply is the same as Q114-Q214 negative supply, to assure signal linearity in the event of common-mode signal cancellation by Q124.

The principal reason for keeping the common-mode currents out of the Preamplifier is that even though the currents may be equal, the collector load resistors may not be precisely equal, and equal currents would generate unequal output voltages. The circuit does stop the Preamplifier output from moving positive or negative with common-mode signals.

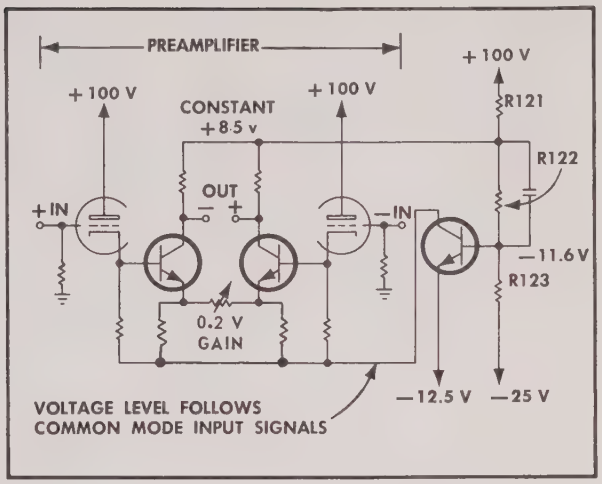

Fig. 3-3. Simplified Constant Current stage connections to Preamplifier.

Response Filters. The frequency response of the overall monitor is altered for special purposes by the RESPONSE switch and its filters.

The FLAT position of the RESPONSE switch gives the widest bandwidth, with a direct connection from the Preamplifier to the Output Amplifier.

The IEEE position of the RESPONSE switch inserts components that cause the overall monitor bandwidth to be low-pass to agree with 1958 Standard 23S-1.

The LOW PASS position of the RESPONSE switch inserts components that alter the overall response so that it is about 12-dB down at 500 kHz.

The HIGH PASS position of the RESPONSE switch inserts a critically-coupled transformer between the Preamplifier and the Output Amplifier, making the overall monitor bandpass about 800 kHz centered at 3.58 MHz. The DC level at the input of the Output Amplifier is maintained by connecting the center of the primary and secondary windings together at a cold rf point.

Output Amplifier. The Output Amplifier includes two sets of push-pull amplifiers, each with variable emitter coupling to vary the gain. The first amplifier is Q144-Q154 and Q244-Q254. The second amplifier is driven by the first, and is a combination of transistors and tubes giving a large voltage output swing.

The driver portion of the amplifier has negative feedback from the collector of Q154 to the emitter of Q144 (and from Q254 to Q244). The negative feedback makes the input impedance at the base of Q144 very high and the output impedance at the collector of Q154 quite low. The high input impedance prevents loading of the response filters. The low output impedance is needed to drive the base of Q164 (and Q264). R154 is the negative feedback path and is also the collector load resistor for Q154 (see Fig. 3-4).

The VARIABLE gain control (concentric with the VOLTS FULL SCALE switch) varies the emitter-to-ground degeneration between Q144 and Q244 to vary the overall Vertical

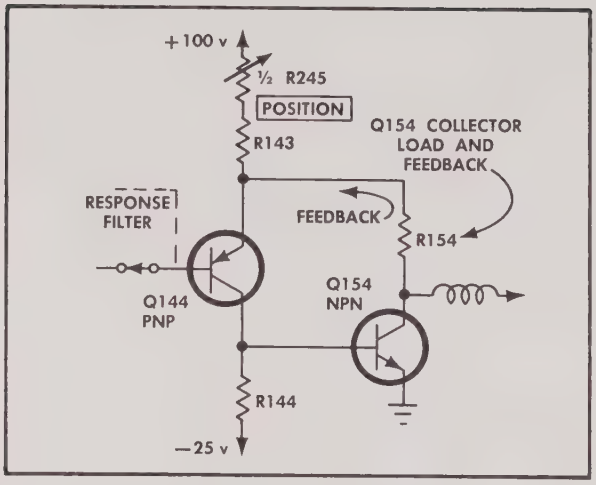

Fig. 3-4. Simplified one-half output driver stage.

Amplifier gain by a 2.5:1 ratio. The VARIABLE control mechanically switches R241 into the circuit in the CALIB position, and out of the circuit (SW240 closed) when not in the CALIB position. If the VARIABLE control is counterclockwise at lower than calibrated gain, clockwise rotation can increase the monitor gain so it is greater than normal. Then, as the clockwise end of rotation is reached and the control is rotated to snap into the CALIB position, the overall gain drops about 70% as R241 is switched into the circuit. At the same time a second part of SW240 closes and turns on the front-panel CALIB neon lamp.

The output driver signal is coupled to the base of Q164 (Q264) of the output cascode amplifier. The combination of a transistor (supplying cathode drive) and a tube not only gives stable gain but also gives the wide voltage output swing. This amount of swing can only be obtained by a cascode amplifier consisting of a tube and transistor. The output cascode stage also has emitter-to-emitter degeneration used to adjust the overall Vertical Amplifier gain to match the crt deflection factor. The emitter circuit also contains the HF COMP capacitors that permit the output stage high-frequency gain to be adjusted a bit higher than the low-frequency gain. This adjustment helps make the bandpass correct for the FLAT position of the RESPONSE switch.

While reading the following description of the cascode stage operation, keep in mind that (1) a transistor's emitter follows its base, just as a tube's cathode follows its grid—if the return circuit is a higher impedance than the internal emitter or cathode impedance, and (2) a transistor's collector is a quite high impedance, as high as the plate impedance of some triode tubes.

A signal that drives the base of Q164 in the positive direction causes several simultaneous circuit changes. The emitter voltage of Q164 follows the base voltage, with emitter voltage change about 2 percent less than base voltage change, offset by normal silicon transistor bias. The positive swing of Q164 base drives the grid voltage of V164 positive the same amount, and the cathode of V164 follows, lagging its grid by about 20 percent. The 20-percent positive bias occurring in V164 as a result of cathode-follower action increases plate current, and the consequent plate current increase causes the output plate voltage to drop in the negative direction an amount determined by R162 and Ohm's Law.

Push-pull signals that drive the bases of Q164-Q264 drive the two halves of the output stages equally. (The degenerative action of the resistors between emitters is one half what it would be if only one base received a signal). The signal voltages at Q164-Q264 bases cause plate-current changes of V164 and V264 to be about 3.3 mA per centimeter of spot deflection each, producing a push-pull voltage output to the crt deflection plates of about 20 volts per centimeter. The peaking coils in each plate circuit compensate for deflection-plate capacitance, and aid in obtaining flat frequency response of the Vertical Amplifier.

Positioning the crt display (with DC RESTORER OFF) is by current injection into the emitter circuits of Q144-Q244 through R143 and R243. The POSITION control (R245) sends current toward the cascode output stage bases, but this current does not affect the display position so long as the Dc Restorer circuit is off. Voltage changes at the bases of Q164 and Q264 do not significantly affect the positioning circuit because the two germanium diodes D271-D272 limit the voltage difference between R149-R249 junctions with R148-R248. The two diodes appear on the Dc Restorer diagram.

Operation With DC RESTORER ON

The Dc Restorer circuit provides an automatic dc positioning voltage to the —input grid of V113B. The source of dc positioning voltage is the signal in the base circuit of the output cascode stage. The signal is usually composite video (sometimes it is the calibrator). The Dc Restorer circuit positions the crt display firmly around the level of the composite video horizontal sync pulse back porch. Because of these facts, the restorer must look at the video only at the correct time. The Dc Restorer circuit is keyed by the horizontal trigger system to sample the video back porch for about 0.4 μs, and remember the dc level until the next horizontal sync pulse occurs.

When the Dc Restorer circuit is on, a current injection path through R148 and R248 into the input of the Dc Restorer Comparator permits the POSITION control to operate. The positioning current changes the dc level of the composite video at the point where it is looked at by the Restorer.

Video Output Amplifier. The Video Output Amplifier receives its signal from the emitter of Q114. The input impedance of Q174 is greater than 50 kΩ due to the large amount of emitter degeneration, which loads Q114 lightly. Q174 produces an inverted current drive to the feedback amplifier Q184-Q193 of essentially 1 mA per 1 volt. The emitter impedance of Q174 is R172-R173 in parallel. Since the collector current of Q174 changes linearly with base-voltage drive, the signal-source resistance of Q184 base is equivalent to the parallel resistance value of R172-R173. Then, the voltage gain of Q184-Q193 (set by the feedback resistance divided by the input resistance) is 2.06. Assuming 3% signal loss in the Preamplifier, the gain from input to Q193 collector is 2. R198 in series with a 75-ohm load makes the overall gain 1. The feedback (R192) makes the Video Output Amplifier have a very low output impedance. Thus,

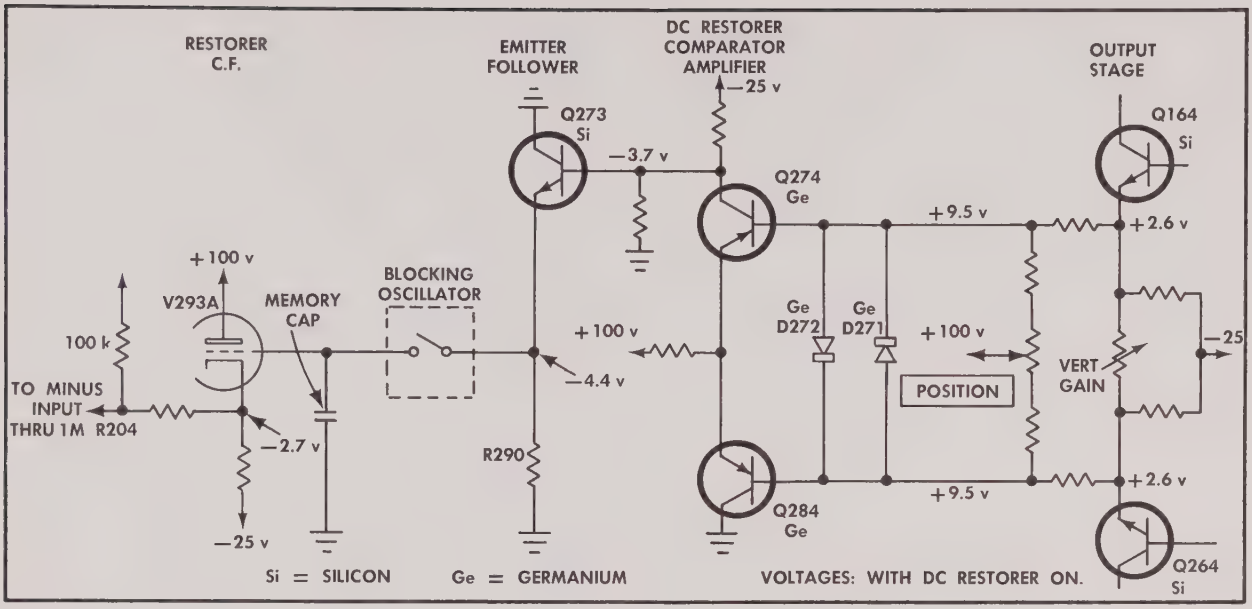

Fig. 3-5. Simplified keyed Dc Restorer circuit.

the amplifier is matched to the output coaxial line by inserting a series 75-ohm resistor (R198). The reactance of C198 is so low at the frequencies passed by the circuit that it does not increase the output resistance over that of R198. R199 assures that C198 is properly charged.

The Video Output Amplifier also serves as an internal trigger amplifier. The output lead to the Sync Clamping Amplifier (diagrammed with the Sync Separator) rests at −5 volts.

The Sweep Generator applies a positive pulse to the Video Output jack when operating in the line selector mode. The intensifying pulse amplitude is about 0.2 volt at the Video Output jack (0.1 volt when loaded with 75 ohms). The value of the pulse is set by current from a +100-volt pulse in the Sweep Generator unblanking circuit applied through R476 (diagrammed near the Unblanking Amplifier with the Sweep Generator) to the output resistor R198. The very low output impedance of the Video Output Amplifier prevents the intensifying pulse from distrubing the internal triggering signal.

KEYED DC RESTORER

The keyed DC Restorer circuit includes the Dc Restorer Comparator, the Blocking Oscillator, and the Restorer Cathode Follower. Voltages and waveforms on the Dc Restorer diagram were taken with the Dc Restorer circuit on. The simplified diagrams of Fig. 3-5, 3-7 and 3-8, and waveforms of Fig. 3-6 will help during the following discussion of the Dc Restorer circuit operation.

The Dc Restorer Comparator is a dual-input single-output amplifier that amplifies a small part of the composite video which is normally near the crt screen center. The signal peaks are limited by parallel back-to-back germanium diodes D271-D272 (see Fig. 3-5). One of the two diodes conducts whenever the voltage across them exceeds 0.2 to 0.3 volt. When the diodes are not conducting, the Comparator bases are fed push-pull signals from the two bases of the Output Amplifier cascode stages. When a diode is conducting, the two bases of the Comparator Amplifier are essentially shorted together, and there is no gain. When the signal at the base of Q274 goes negative (and the signal at the base of Q284 goes positive) D271 conducts. The opposite polarity signal causes D272 to conduct. The peak-to-peak signal input to the Comparator is, therefore, limited to about 0.45 volt. The Comparator output signal is typically 4.2 volts peak to peak at the emitter of the Emitter Follower (Q273). The Comparator functions in the same manner as the differential Preamplifier previously described, except there is just one output lead. Fig. 3-6d shows the signal as it enters the Memory Gate. The other waveforms of Fig. 3-6 are discussed with the Blocking Oscillator below.

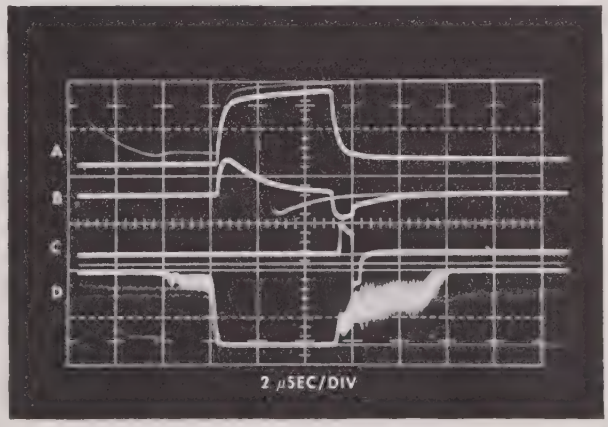

Fig. 3-6. Time-coincident waveforms of keyed Dc Restorer.

Blocking Oscillator. The Blocking Oscillator is normally biased to cutoff by current through R282 and D282. A negative pulse applied to the base of Q280 will cause it to conduct and go through one cycle of oscillation. The negative pulse arrives at the base of Q280 through a diode switching network from the Sync Regenerator (diagrammed with the Sync Separator).

Assume the vertical INPUT switch is at A, as shown in Fig. 3-7. The diode switching circuit then reverse biases D285 about 45 volts and reverse biases D286 about 1 volt. Regenerated horizontal sync pulses arriving at C285 and C286 have a peak-to-peak amplitude of about 8 volts. Thus, the —H pulse will not cause D285 to conduct, but the +H pulse will cause D286 to conduct at the end of the pulse as it goes negative. C286 charges almost the full 8 volts of the +H pulse rise, and then causes the cathode of D286 to fall about 7 volts. The base of Q280 does not fall as much as 8 volts because of the base-to-emitter low impedance at the time of turn on.

The Blocking Oscillator turns on at the time the composite video horizontal sync pulse ends and starts toward the back-porch level. The back-porch level occurs about 0.25 μs later, so the Blocking Oscillator does not sample the video at the time of turn on. As Q280 conducts, the L/R time constant of the collector circuit inductance and resistance keeps Q280 conducting for about 0.6 μs before the base drive decays. As Q280 regenerative base turn-on drive is stopped, the collector current drops rapidly. Dropping collector current is transformer-coupled back to the base of Q280 as a fast turn-off signal. The collector voltage waveform is shown in Fig. 3-6c. Changing collector current is also transformer-coupled to the tapped secondary that drives the Memory Gate.

Memory Gate. The Memory Gate consists of the center-tapped secondary of T280 with its dc level set by the Emitter Follower, two parallel rc circuits and two silicon diodes. As Q280 is turned on, the secondary voltage of T280 reverse biases D292 and D293 and no current flows. As Q280 stops conducting, the secondary of T280 drives D292 and D293 into conduction and at the same time charges both C292 and C293 to about 7 volts. (The energy for charging the two capacitors comes from the core of T280.) D292 and D293 are computer diodes with equal forward drop at the time they conduct, making the voltage at their junction with C294 equal to the voltage at the center of T280 secondary. Thus, during the backswing time of T280, the voltage at the center of T280 secondary appears at C294. The backswing lasts for about 0.4 μs, which is plenty of time to fully charge C294 to the voltage of the Emitter Follower. During each backswing, C292 and C293 are recharged to replace the small amount of voltage discharged by the resistors R292 and R293. The time constant of the two rc circuits is 1 ms each, many times longer than the 63.5 μs between sampling times.

Memory Circuit. The Memory Circuit is the Memory Capacitor C294 and the grid of V293A. Since D292-D293 are silicon diodes with very high reverse leakage, the Memory Capacitor charge is essentially constant between samples.

The four waveforms of Fig. 3-6 (taken with a four-channel oscilloscope) show the time-coincidence of the Dc Restorer circuit. Note that some of the color burst is seen by the Memory Gate and Memory Capacitor. The reactance of the Memory Capacitor is about 440 ohms at 3.58 MHz; and the sampling diodes are turned on hard by T280 secondary so there is no color-burst rectification. Thus, the Dc Restorer circuit acts upon the average voltage of the color burst, keeping the display at the same stable position with or without the color burst.

Restorer Cathode Follower. The Restorer Cathode Follower acts as an impedance transformer that couples the sampled and stored voltage into the Vertical Amplifier minus input grid. The two resistors, R298 and R299, offset the dc

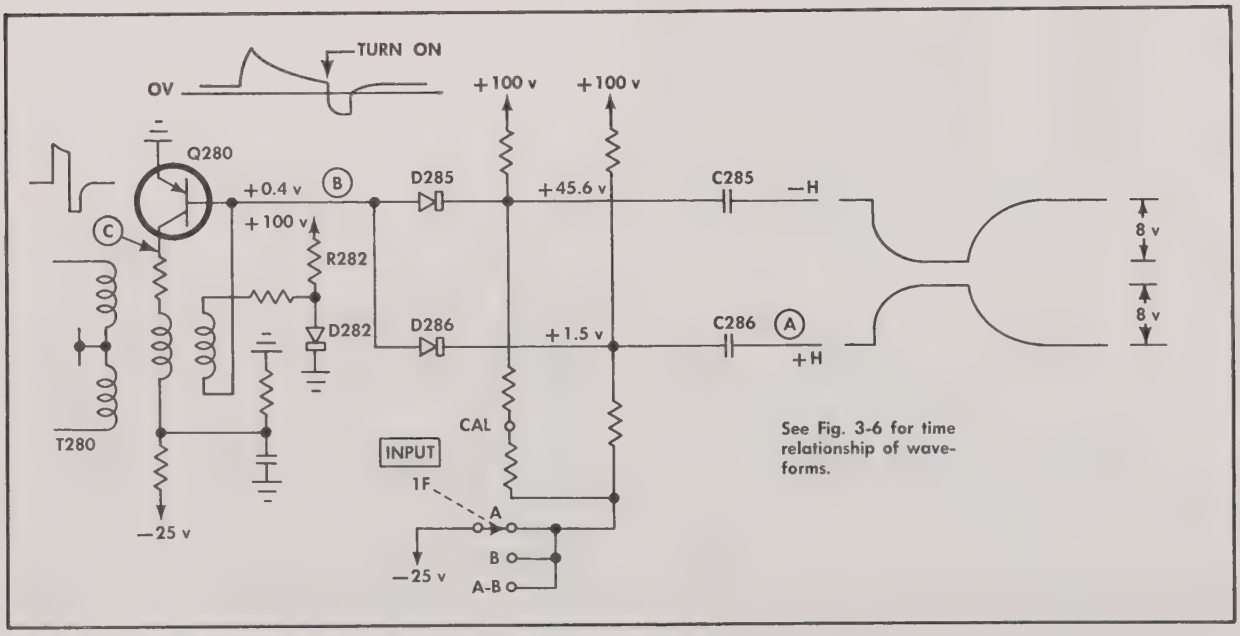

Fig. 3-7. Operation of Diode switch feeding Blocking Oscillator.

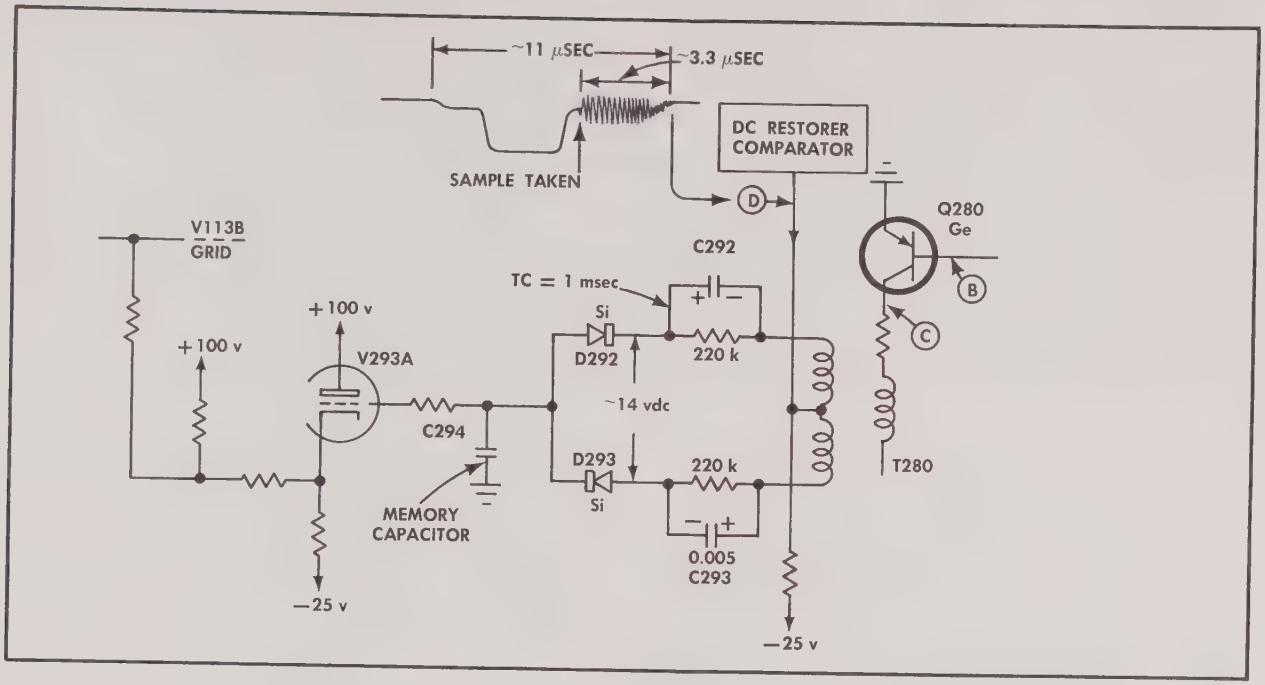

Fig. 3-8. Sampling and memory portions of Dc Restorer circuit.

level of V293A cathode to the correct value for the minus input, setting the minus grid to essentially ground voltage when the system is correctly balanced.

Restorer Operation on Calibrator Signal. This mode of Restorer operation uses the —H regenerated horizontal sync pulse to fire the Blocking Oscillator. The —H signal starts negative at the same time the Calibrator signal goes negative. The Blocking Oscillator fires as the —H signal goes negative, causing the DC Restorer circuit to sample the signal voltage about 0.88 μs after the beginning of the Calibrator negative half-cycle. Thus, the display is stabilized at the bottom of the Calibrator signal and held in the same position as the back porch.

SYNC SEPARATOR

The Sync Separator processes composite video so the Sweep Generator is triggered properly for the various modes of the DISPLAY switch.

The input to the Sync Clamping Amplifier can be from one of two sources; the internal trigger signal from the Video Output Amplifier or an external sync input, usually composite video. The selection of source is made by the SYNC switch. Source switching is by diodes, and the actual SYNC switch is isolated from the video leads by R305. When the SYNC switch is set to INT, D301 is back biased and D304 is forward biased. The signal passes through forward-biased D304 into the grid of V293B. When the SYNC switch is set to EXT, D304 is back biased and D301 is forward biased, so the signal passes through D301. The internal-external sync selection can be made from the front panel for all vertical input modes except when viewing the calibrator signal. When the vertical INPUT switch is at CAL, the sync input is automatically switched over to internal.

Sync Clamping

The Sync Clamping Amplifier has two feedback loops. One is a normal type consisting of R315, with the gain of Q314 set by R315 and the transconductance of V293B.

A feedback amplifier of the type in the Sync Clamping Amplifier, and diagrammed in Fig. 3-9, has low input impedance called virtual ground, and a low output impedance. The virtual ground is easy to visualize when we find equal and opposite currents in the input resistor (R_i) and the feedback resistor (R_f). Assume R_f of Fig. 3-9 to be 22 kΩ and R_i to also be 22 kΩ. A one-volt IN signal will cause 0.045 mA to flow in R_i. The transistor collector will change voltage level (also 1 volt) until an opposite 0.045 mA flows in R_f at which time the input signal is balanced, so none is left for the base. When $R_i = R_f$ the voltage gain is unity.

V293B cathode output impedance is approximately equal to 1/Gm or typically 1/0.001 S^1 = 1000 Ω. (Normal range of output resistance between tubes will be from about 600 to 1200 Ω.) The cathode-follower output resistance can be considered directly in series with the input grid for calculating signal current to the base of Q314. Thus, the typical voltage gain of Q314 is $\frac{22\text{ k}\Omega}{1\text{ k}\Omega} = 22$.

[1]siemens = mho

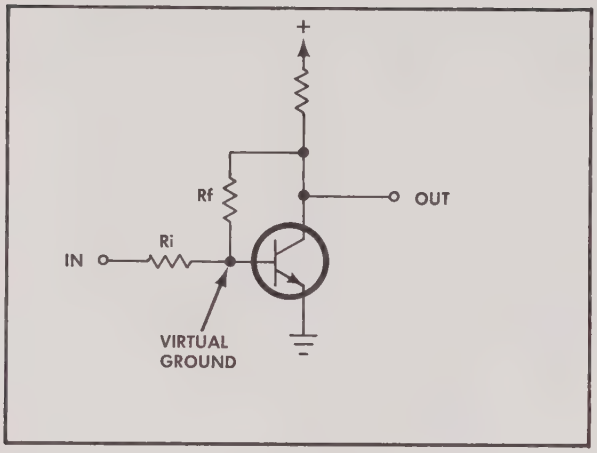

Fig. 3-9. Simplified Feedback amplifier.

A second feedback loop around the Sync Clamping Amplifier is composed of R317, R318 and C317. This loop acts as a dc restorer for signals into the rest of the triggering circuitry. Negative-going composite video at the grid of V293B causes the collector of Q314 to go positive. As each negative-going sync tip occurs, C304 charges slightly positive, then as the collector voltage of Q314 falls, C317 gains a negative charge that is the average of the input signal amplitude. C304 thus receives a charge as each sync tip occurs, then discharges through R317 to C317 at all other times. The discharge current for C304 is approximately proportional to video level. The effect of the action just described is that C304 acts as a DC restorer for the Sync Clamping Amplifier for a wide range of signal levels. Restorer action thus holds the Sync Clamping Amplifier output (at the sync pulse tips) at a stable level of about —0.5 volt.

Any large noise pulses riding on the negative-going composite video will cause the collector of Q314 to go positive enough to back bias D318; while at the same time, the large negative going pulse at the grid of V293B will cause D317 to be forward biased. Forward biased D317 will now cause the charge rate of C304 to be limited by R319.

Video stripping occurs in the Sync Clamping Amplifier as the input signal goes positive, because available Q314 collector current through R314 is all taken by the feedback resistor R315. As V293B cathode applies positive-signal turn-off current to the base of Q314, Q314 collector goes negative until the current in R315 equals the current in from V293B cathode. At that point, the collector voltage stops going negative and the remaining positive signal input to V293B grid is not amplified. Thus, the dc-restored sync tips out of the Sync Clamping Amplifier have a maximum peak amplitude of about 13 volts with the video information removed from large signals.

Sync Regenerator

The Sync Regenerator is a Schmitt multivibrator whose operation is bistable due to the dc coupled input signal from Q314 collector. Q335 conducts when the base of Q325 is near ground, and Q325 conducts when the input is more negative than about —4 volts. Output signals are each about 8 or 9 volts peak to peak. The TRIG MULTI BIAS control is adjusted for proper triggering on low-level video sync signals in case the Sync Regenerator input signal is less than normal.

Assume Q325 is conducting. As the input signal goes positive, current in Q325 is reduced, allowing its emitter to go positive and its collector to go negative. Q325 emitter is coupled to Q335 emitter and Q325 collector is coupled to Q335 base. Initially the back bias at the base-emitter junction of Q335 prevented it from conducting. As Q335 bias reaches the point of conduction, regenerative action flips the conduction from Q325 to Q335 rapidly. As long as a sync tip holds the base of Q325 up near ground, Q335 will conduct. As Q325 base starts negative, Q325 begins to conduct and a second regenerative action switches Q335 off and Q325 on. The regenerative path is between the emitters of Q325-Q335 and from the collector of Q325 to the base of Q335.

Both the +H and —H signals are available for the keyed DC Restorer circuit previously described, and for the rest of the triggering circuitry.

FIELD SELECTOR

The Field Selector circuit includes the Vertical Sync Separator, the Field 1 Recognition circuit and the Field Trigger Generator.

Vertical Sync Separator. The Vertical Sync Separator is primarily a differentiator and an amplifier biased off about 3 volts. The differentiator, C341-R341, shifts the signal output DC level depending on the pulse duty cycle. If the incoming square-wave signal negative peaks are of longer duration than the positive peaks, the output will be more positive than negative. Likewise, if the incoming signal positive peaks are of longer duration than the negative peaks (vertical sync), the output will be more negative than positive. During the time C341 receives only regenerated horizontal sync pulses, the signal at the base of Q344 shifts between about 2 volts negative and 6.5 volts positive and Q344 does not conduct. As the vertical sync group occurs, the signal at the base of Q344 shifts to between about 6 volts negative and 2.5 volts positive, turning Q344 on each time the signal goes below about —3.5 volts.

Both the Field 1 Recognition circuit and the Field Trigger Generator require a single pulse, the first of the vertical sync pulses. The parallel combination of R346-D346 and the capacitance of C347 allow only the first vertical pulse to pass through. As the collector of Q344 rises positive 20 volts, D346 passes the whole pulse to C347 (and C351). C347 charges to more than half the peak voltage of the first pulse. The very high reverse resistance of D346 and the resistance of R346 let C347 keep its charge. The second vertical sync pulse is, thus, not able to be coupled on since the cathode of D346 is already several volts more positive than it was before the arrival of the first pulse. (Some of the second pulse gets through the coupling capacitors, but does not affect the following circuits.) R346 discharges C347 (and C351) before the next vertical pulse arrives.

Field 1 Recognition. The Field 1 Recognition circuit is a one-shot multivibrator (mono-stable) with two input paths. The single vertical sync pulse that arrives through C351 to the base of Q355 turns Q355 on and Q365 off. The switching action is regenerative due to emitter coupling, and coupling from Q355 collector to Q365 base. C360 was initially charged to about 13 volts. As Q355 collector falls, the base of Q365 is taken about 11 volts negative. The FIELD 1 SYNC control (R360), in series with R361, starts the base of Q365 back toward ground, discharging C360. As the voltage at the base of Q365 nears a value that would cause Q365 to turn on, a positive pulse coupled to the base through C361 will turn it on and reset the multi. The time constant of C360 and R360-R361 is set such that the multi is reverted at the end of the last vertical equalizer pulse. (The waveforms at the collector of Q365 on the diagram at the back of this manual show capacitively-coupled pulses that pass through C361 and the base-to-collector capacitance of Q365. This is normal and does not indicate Q365 to be defective). As Q365 collector goes negative at the end of the last equalizing pulse, C364 and R368 form a negative pulse that ramps up for a period of 50 to 55 μs. C370 couples differentiated —H pulses and adds them to the ramp at the junction of R369 and D370. If a horizontal pulse occurs during the time the ramp is running up, the output through D370 is more negative than at any other time. A two-field interlace horizontal sync pulse occurs in the middle of every other ramp.

All the other negative pulses at the junction of R369-D370 charge C371 (through R372) to an essentially stable dc voltage (R371 does not appreciably discharge C371 between pulses). As a field two occurs, the more negative pulse that coincides with the field one recognition ramp is coupled through D371 to the base of Q375, flipping the Field Trigger Generator so that Q375 conducts.

Field Trigger Generator. The Field Trigger Generator is a bistable multivibrator that changes state each time a positive pulse arrives through C347 from the Vertical Sync Separator. The triggering pulse is coupled to the bases of Q375-Q385 through diodes D374-D384 and the rc networks of C375-C385. The positive-polarity pulse turns off the conducting transistor regardless of which is conducting. The pulses arrive at a 60-hertz output rate, causing the Field Trigger Generator to have a 30-hertz output rate at each collector.

If Q375 is off when the negative-going field one signal from the Field 1 Recognition circuit arrives at the base of Q375, then Q375 will be turned on. A positive signal from the sync separator to each collector at the start of each field, and a negative pulse to Q375 base at each field one assures that the Field Trigger Generator output is always related to field one and field two of the composite video. The collector of Q375 always goes positive (toward ground) at the beginning of each field one. The collector of Q385 always goes positive at the beginning of each field two.

Field shift switching is the selection of the correct Field Trigger Generator output pulse by a dual-input single-output diode switch. Positive-going trigger pulses are needed by the Sweep Generator and by the Delay Generator. Thus, to trigger on a field one, the Field Shift switch causes Q375 collector signal to be coupled on, and for a field two, Q385 collector signal to be coupled on.

Assume a field two trigger is selected. The crt display will start the sweep on a field two and show the field one at center screen. The FIELD switch (set at TWO) applies a negative bias to D377 anode, assuring that it cannot conduct the signal from Q375 collector to the following circuits. D387 will pass the positive portion of the differentiated Q385 collector signal. Differentiation of Q385 collector signal is by C384 and the parallel resistance of R388 and R411-R412. As Q385 collector rises, C384 couples the first of the full step through to D387 and the rest of the circuit. C384 soon charges, dropping the voltage at the cathode of D387 back to ground level. As Q385 collector falls, D387 disconnects the signal from the rest of the circuit and R388 recharges C384 for the next positive pulse. The contacts of K501 are described with the Staircase Amplifier later in this section.

LINE SELECTOR

The Line Selector circuit includes the Delay Generator and the Line Pickoff circuit. The selected line-trigger pulses occur once each field, an adjustable amount of time after each vertical sync pulse.

Delay Generator. The Delay Generator is normally biased so Q425 is conducting and Q415 is cut off. Q415 collector rests at +24 volts because of the voltage divider R417, R418, R419 and Q434. (The LINE SELECTOR control current from —25 volts through R402 to the junction of R419-C428 will not take the junction significantly below ground because there is 24 volts across R419 and there can be up to 25 volts across R402.) Q425 collector rests at —1 volt, holding Q415 base at about —2.6 volts by the drop across R421-R422. Q414 is saturated (collector voltage pulled down very near emitter voltage) due to base current through R416. Thus, the current in Q425 emitter and collector is set by R414 and the —24 volts at Q414 collector. The Delay Generator will remain in this condition until a positive trigger pulse arrives at the base of Q415.

As a positive pulse turns on Q415, the current through Q414-R414 shift to Q415 and Q425 turns off. As Q415 collector starts negative, C416 couples the voltage change into the base of Q414 in a direction to reduce its collector current. As the base of Q414 is taken far enough negative to almost turn off its collector current, the drop in Q415 collector voltage is nearly stopped until the current through R416 discharges C416. As C416 discharges a bit, the base voltage of Q414 turns on a bit more current. The current of Q414 is also the current in Q415, which again pulls down on C416. The result of the feedback just described is that C416 is discharged in a very linear manner by current through R416. The voltage at the junction of C416-R416 remains essentially constant while the collector of Q415 pulls the other side of C416 negative at a rate set by the current of R416.

When the collector voltage of Q415 reaches ground level and stops going negative, current through R416 raises the base voltage of Q414 and increases its current. Increased current in Q414 pulls both Q415 emitter and base elements negative, allowing the collector to go negative too. The common emitter-to-emitter lead of Q425-Q415 drops negative until Q425 again turns on. The collector voltage of

Q425 drops and quickly turns Q415 off, letting its collector voltage rise in the positive direction as R417 charges C416 to its original state. (C418 cancels Q415 initial negative collector surge caused by shifting Q414 current from about 5 mA in Q425 to about 0.27 mA in Q415. Without C418, the collector voltage of Q415 would drop sharply negative at the time Q415 was triggered into conduction.) C416 charging current is limited only by R417 since the negative end of the capacitor is tied to —25 volts through Q414 base-emitter junction.

SWEEP GENERATOR (SN 998-up)

The Sweep Generator is a triggered sweep system for all positions of the DISPLAY switch except the 2 FIELD position at which it is a recurring synchronized sweep. Positive field-trigger pulses stop the sweep in 2 FIELD and both LINE SELECTOR positions (LINE SELECTOR set to a line, lines 16 through 21) operation, negative line-trigger or selected line pulses start the sweep in all other modes of operation. The sweep rate at 2 LINE permits viewing the interlacing of the color burst. The sweep rate at 0.125 H/cm lets you look at every other horizontal line displaying a non-interlaced color burst. Refer to the diagram at the back of this manual during the following circuit description.

Trigger Selector Matrix

Selection of recurrent negative line trigger pulses at the beginning of each horizontal line, or of selected line pulses, is made in a diode switching network of the DISPLAY switch.

When the DISPLAY switch is at a LINE SELECTOR position and the LINE SELECTOR switch is set to a line (lines 16 through 21) position, both D441 and D444 are reverse biased so that no negative triggers get to the Sweep Gating Multi. At the same time, D452 is forward biased through R449 so positive field triggers are available to the Sweep Gating Multi.

When the DISPLAY switch is at its LINE SELECTOR positions and the LINE SELECTOR switch is set to VARIABLE, the cathode of D441 is raised about 9.5 volts positive and the diode is reverse biased so it cannot conduct negative line triggers to the Sweep Gating Multi. D444 (D436) does conduct negative selected line pulses to the Sweep Gating Multi.

When the DISPLAY switch is at 2 LINE, .25 H/CM, or .125 H/CM, D444 (D436) cathode is reverse biased about +29 volts to prevent selected line pulses from getting to the Sweep Gating Multi. D441 does conduct negative line-trigger pulses to the Sweep Gating Multi.

When the DISPLAY switch is at 2 FIELD, both D441 and D444 are reverse biased to that no negative triggers get to the Sweep Gating Multi. At the same time, D452 is forward biased through R450 so positive field triggers are available to the Sweep Gating Multi.

Sweep Gating Multi

The Sweep Generator is operated in two basically different modes of operation as suggested eariler. The Sweep Gating Multi operation is altered from a triggered system for 2 LINE, .25 H/CM, .125 H/CM and both the LINE SELECTOR positions (LINE SELECTOR switch set to VARIABLE) line displays to a stopped-sweep system for both LINE SELECTOR positions (LINE SELECTOR switch set to a line, lines 16 through 21) displays, and to a free-running stopped-sweep system for 2 FIELD displays.

2 LINE DISPLAY. (Vertical INPUT switch at A, DISPLAY switch at 2 LINE.) The Sweep Generator is held on one state by the Sweep Gating Multi until the arrival of a negative trigger pulse. Before receipt of a trigger pulse, the following conditions exist:

a. Q455 is conducting, Q465 is in a state of non-conduction.

b. Both disconnect Diodes are conducting. D482 is applying positive turn-on current from R468 to the Miller Runup input base, while D481 is limiting the turn-on current, as the collector of Q481 pulls down and takes some of the current flow from R468.

c. Q481 collector voltage is at about +1 volt, so that essentially no current is delivered through R520 to the Horizontal Amplifier.

d. The Unblanking Amplifier output is near ground, turning off the CRT beam.

e. The CRT horizontal deflection plates hold the blanked beam at the left side of the CRT (depending upon the setting of the POSITION control).

Q455 is held in conduction by current through the series resistors R464-R465 and RD466, limited by R470 current into the base-emitter junction of Q474. The base turn-on current to Q455 is enough to saturate it; however, D455 bypasses some of the intended base current when the collector voltage drops slightly below the D466 anode voltage, which prevents the transistor from saturating. (If Q455 were to saturate, the base-emitter junction would hold so many carriers that the transistor could not be turned off quickly.) The fact that Q455 collector voltage is near ground asures that no current reaches the base of Q465, and Q465 remains cut off.

As the negative going line trigger pulse arrives at the base of Q455 through C452, Q455 is turned off. The voltage rise at the collector of Q455 is coupled to the base of Q465, turning it on. As current begins to flow in Q465, its collector voltage drop aids in turning Q455 off and the switching action takes place very rapidly. Consider the emitter of Q465 as grounded; the components in its emitter circuit are used in 2 FIELD and LINE SELECTOR (LINE selector switch set to a line, lines 16 through 21) operation, and are of no importance in 2 LINE operation.

Miller Runup

As Q465 collector voltage falls below about +1.3 volts, D464 conducts, and takes the anodes of the Disconnect Diodes toward ground. Both D481 and D482 stop conducting. The timing resistor current that had been flowing through D482 is immediately transferred to the base timing capacitor (C481). As Q483 base starts negative, the base of Q481 also starts negative and reduces its collector current, causing its collector voltage to start positive. The timing capacitor couples the positive voltage of Q481 collector back to Q483 base, essentially stopping its negative travel. The result is that the timing capacitor receives a charge at a rate set by the timing resistor, creating a very linear positive-going sawtooth voltage at the collector of Q481. The Miller Runup circuit can be defined as a feedback amplifier, with the

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feedback element a timing capacitor, and the input resistor a timing resistor; the input signal is the —25-volt supply.

The sweep voltage rises positive until R492 raises the base voltage of Q455 far enough to revert the Sweep Gating Multi. As Q455 conducts, the collector voltage of Q465 raises in the positive direction. D464 stops conducting and R468 raises the base voltage of Q483 positive through D482. This causes collector current in Q481 to increase rapidly. This collector current discharges the timing capacitor at a linear rate set by R468. As Q481 collector voltage becomes slightly less positive than the anode of D481, D481 conducts and stops the rundown. (D486 offsets the base voltage of Q481 in a direction to limit the quiescent current in D481, permitting the next sweep runup to start linearly.) The rate of rundown is slow enough that the sweep is triggered every other horizontal sync pulse, presenting a non-interlaced color burst. The Sweep Generator then waits for another negative line-trigger pulse to turn off Q455 and start the cycle over again.

2 FIELD DISPLAY. Operation of the Sweep Gating Multivibrator is changed from a state where a trigger is required to start the sweep, to a condition where the sweep starts automatically and is stopped by a trigger pulse. If the sweep is not running when the DISPLAY switch is set to 2 FIELD, Q465 of the Sweep Gating Multi is not conducting. The DISPLAY switch connects R461A to the —25-volt supply and the emitter voltage starts negative. D461 is reverse, biased, and the rate of fall is set by the time contant of R461A - C463. Approximately 1 millisecond after Q465 emitter voltage starts negative, the Sweep Gating Multi switches so that Q465 is on and Q455 off. The sweep voltage runs up as described for 2 LINE operation.

The DISPLAY switch also changes the output of the Trigger Selector Matrix, forward biasing D452 through R450 so that positive pulses will come through D452, and will turn on Q455 to stop the sweep. The positive pulse that turns Q455 on occurs at every other vertical sync pulse. The sweep is stopped, runs down very rapidly due to additional rundown current from R453 in parallel with R468, waits 1 millisecond and automatically starts again, just before the video portion of the next field.

In the event vertical input composite video stops, the sweep will continue to cycle, but instead of positive pulses stopping the sweep, Q455 is turned on by sweep voltage feedback through R491-R492 in the same manner as described for 2 line operation. Thus, the Type 529 Monitor will show a sweep without vertical information when the DISPLAY switch is set to 2 FIELD, but requires a trigger signal from the sweep to operate in all other positions of the DISPLAY switch.

With the INPUT switch set to CAL, R469, is placed in parallel with R468 so the rundown rate will be rapid enough to prepare the sweep to run again at the next calibrator signal transition. This assures a cleanly triggered Calibrator display without the possible jitter caused by a longer rundown.

The runup rate of the Miller Runup circuit is slowed by adding C483 across the timing capacitor used in 2 LINE operation. C483 does not affect the sweep voltage peak value, but changes only the rate at which the spot moves across the CRT. Television systems with different time per field than the 30-hertz U. S. A. rate require a change in the value of C483 to change the sweep rate. For longer time per field, increase C483 value; for less time per field, decrease C483 value. Modification of C483 is normally made at the factory at the time of purchase.

The Miller Runup circuit drives both the Horizontal Amplifier and the Staircase Amplifier.

LINE SELECTOR DISPLAY. (LINE SELECTOR switch set to line 21) Operation of the Sweep Gating Multivibrator is changed from a state where a trigger is required to start the sweep to a condition where the Sweep Gating Multivibrator starts automatic, runs until a —H pulse latches it and causes it to switch and start the sweep voltage running up. After the sweep voltage has run up, the Sweep Gating Multivibrator is reset by a field selected frame trigger pulse. If the sweep is not running when the DISPLAY switch is set to the LINE SELECTOR position (LINE SELECTOR switch set to line 21), Q465 of the Sweep Gating Multi is not conducting. The DISPLAY switch connects R461A to the —25-volt supply through R461B, R461C, R461D, R461E, R461F and R461G (If FIELD switch is set to 2) and the emitter voltage starts negative. D461 is reverse biased, and the rate of fall is set by the time constant of C463-R461A, R461B, R461C, R461D, R461E, R461F and R461G (if FIELD switch is set to 2). At a time, which is determined by the setting of the LINE SELECTOR switch and the FIELD switch after Q464 emitter voltage starts negative, it will be negative enough to be latched by one of the —H pulses applied through Q462 to the emitter of Q465. The latching by the —H pulse causes the Sweep Gating Multi to switch so that Q465 is on and Q455 off. The sweep voltage runs up as described for 2 LINE operation. After the sweep voltage has run up, the Sweep Gating Multi is reset by a field selected frame rate trigger pulse.

Since the VIT LINE SEL RANGE control, R458, varies the base voltage of Q465 a small amount, it is used to set the exact time that Q465 will turn on.

The DISPLAY switch also changes the output of the Trigger Selector Matrix, forward biasing D452 through R449 so that positive pulses will come through D452, and will turn on Q455 to stop the sweep. The positive pulse that turns Q455 on occurs at every other vertical sync pulse. The sweep is stopped, runs down, waits for the time set by the LINE SELECTOR switch and the FIELD switch, then automatically starts again, just before the desired horizontal line.

Unblanking Amplifier

The Unblanking Amplifier (Q474) responds to the Sweep Gating Multi (Q465) collector signal. When there is no sweep, the CRT beam is pulled away from the deflection plates and phosphor screen, preventing any spot from being seen. Q474 collector is near ground at the time of no sweep, turning off the CRT beam. As the Sweep Gating Multi switches states to start a sweep, Q474 is biased to cutoff and its collector rises to +101 volts, limited by conduction of D474 and D475.

The Unblanking Amplifier provides two more output signals during line selector sweep operation. One is the video output intensification discussed with the Vertical Amplifier description. The other is to increase the CRT beam current to intensify the CRT trace for the short duration of the line selector sweeps.

The collector signal of Q474 does not pull down on the trace intensification line; rather, that line is pulled down

by R476 and the —5 volts of the Video Output Amplifier circuit between sweeps when the DISPLAY switch is set to either Line Selector position. The collector voltage of Q474 is near ground most of the time in line selector modes, because of the short-duration sweeps recurring at the 30-hertz rate (once every 33.3 ms). The trace intensification line (at R477-R478 junction) drops to +5 volts in about 2.6 ms as the combination of R476-R477 discharges C478 and changes the charge on C477.

As the sweep starts, Q474 collector rises quickly, sending an integrated pulse to the CRT grid circuit, R478 permits the step to rise abruptly to +22 volts, then continue to rise at an RC rate. The rising signal to the CRT grid is required to keep the cathode current constant during the intensification period assuring a uniform CRT intensity throughout each sweep.

R476 also conducs current into the 75 ohms of the VIDEO OUTPUT connector, adding about 0.1 volt to the video output to intensify a line of the studio monitor, identifying which line the Type 529 Monitor is viewing.

SWEEP GENERATOR (SN 100-997)

The Sweep Generator is a triggered sweep system for all positions of the DISPLAY switch except the 2 FIELD position at which it is a recurring synchronized sweep. Positive field-trigger pulses stop the sweep in 2 FIELD operation, negative line-trigger or selected line pulses start the sweep in all other modes of operation. The sweep rate at 2 LINE permits viewing the interlacing of the color burst. The sweep rate at 0.125 H/cm lets you look at every other horizontal line displaying a non-interlaced color burst. Refer to the simplified Sweep Generator diagram of Fig. 3-10 and the complete diagram at the back of this manual during the following circuit description.

Trigger Selector Matrix

Selection of recurrent negative line trigger pulses at the beginning of each horizontal line, or of selected line pulses, is made in a diode switching network of the DISPLAY switch.

When the DISPLAY switch is at either of its LINE SELECTOR positions, the cathode of D441 is raised about 9.5 volts positive and the diode is reverse biased so it cannot conduct negative line triggers to the Sweep Gating Multi. D444 does conduct negative selected line pulses to the Sweep Gating Multi.

When the DISPLAY switch is at 2 LINE, .25 H/CM, or .125 H/CM, D444 cathode is reverse biased about +29 volts to prevent selected line pulses from getting to the Sweep Gating Multi. D441 does conduct negative line-trigger pulses to the Sweep Gating Multi.

When the DISPLAY switch is at 2 FIELD, both D441 and D444 are reverse biased so that no negative triggers get to the Sweep Gating Multi. At the same time, D452 is forward biased through R450 so positive field triggers are available to the Sweep Gating Multi.

Sweep Gating Multi

The Sweep Generator is operated in two basically different modes of operation as suggested earlier. The Sweep Gating Multi operation is altered from a triggered system for line displays to a free-running stopped-sweep system for 2 field displays.

2 LINE DISPLAY. (Vertical INPUT switch at A, DISPLAY switch at 2 LINE.) The Sweep Generator is held in one state by the Sweep Gating Multi until the arrival of a negative trigger pulse. Before receipt of a trigger pulse, the following conditions exist:

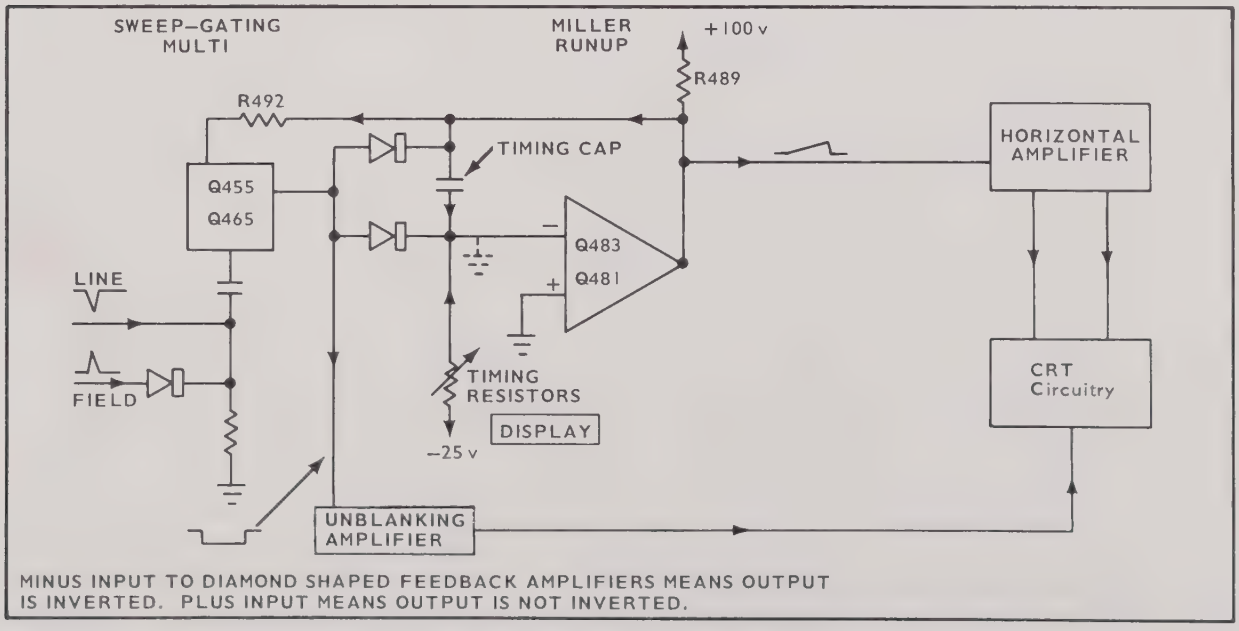

Fig. 3-10. Simplified Sweep Generator.

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a. Q455 is conducting, Q465 is in a state of non-conduction.

b. Both Disconnect Diodes are conducting. D482 is applying positive turn-on current from R468 to the Miller Runup input base, while D481 is limiting the turn-on current, as the collector of Q481 pulls down and takes some of the current flow from R468.

c. Q481 collector voltage is at about +1 volt, so that essentially no current is delivered through R520 (see Horizontal Amplifier diagram) to the Horizontal Amplifier.

d. The Unblanking Amplifier output is near ground, turning off the CRT beam.

e. The CRT horizontal deflection plates hold the blanked beam at the left side of the CRT (depending upon the setting of the POSITION control.

Q455 is held in conduction by current through the series resistors R464-R465 and D466, limited by R470 current into the base-emitter junction of Q474. The base turn-on current to Q455 is enough to saturate it; however, D455 bypasses some of the intended base current when the collector voltage drops slightly below D466 anode voltage, which prevents the transistor from saturating. (If Q455 were to saturate, the base-emitter junction would hold so many carriers that the transistor could not be turned off quickly.) The fact that Q455 collector voltage is near ground assures that no current reaches the base of Q465, and Q465 remains cut off.

As the negative going line trigger pulse arrives at the base of Q455 through C452, Q455 is turned off. The voltage rise at the collector of Q455 is coupled to the base of Q465, turning it on. As current begins to flow in Q465, its collector voltage drop aids in turning Q455 off and the switching action takes place very rapidly. (Consider the emitter of Q465 as grounded; the three components in its emitter circuit are used in 2 FIELD operation and are of no importance in 2 LINE operation.

Miller Runup

As Q465 collector voltage falls below about +1.3 volts, D464 conducts, and takes the anodes of the Disconnect Diodes toward ground. Both D481 and D482 stop conducting. The timing resistor current that had been flowing through D482 is immediately transferred to the timing capacitor. As Q483 base starts negative, the base of Q481 also starts negative and reduces its collector current, causing its collector voltage to start positive. The timing capacitor couples the positive voltage of Q481 collector back to Q483 base, essentially stopping its negative travel. The result is that the timing capacitor receives a charge at a rate set by the timing resistor, creating a very linear positive-going sawtooth voltage at the collector of Q481. The Miller Runup circuit can be defined as a feedback amplifier, with the feedback element a timing capacitor, and the input resistor a timing resistor; the input signal is the —25-volt supply (see Fig. 3-9 and associated text for description of a feedback amplifier).

The sweep voltage rises positive until R492 raises the base voltage of Q455 far enough to revert the Sweep Gating Multi. As Q455 conducts, the collector voltage of Q465 rises in the positive direction. D464 stops conducting and R468 raises the base voltage of Q483 positive through D482. This causes collector current in Q481 to increase rapidly. This collector current discharges the timing capacitor at a linear rate set by R468. As Q481 collector voltage becomes slightly less positive than the anode of D481, D481 conducts and stops the rundown. (D486 offsets the base voltage of Q481 in a direction to limit the quiescent current in D481, permitting the next sweep runup to start linearly.) The rate of rundown is slow enough that the sweep is triggered every other horizontal sync pulse, presenting a non-interlaced color burst. The Sweep Generator then waits for another negative line-trigger pulse to turn off Q455 and start the cycle over again.

2 FIELD DISPLAY. Operation of the Sweep Gating Multivibrator is changed from a state where a trigger is required to start the sweep, to a condition where the sweep starts automatically, and is stopped by a trigger pulse. If the sweep is not running when the DISPLAY switch is set to 2 FIELD, Q465 of the Sweep Gating Multi is not conducting. The DISPLAY switch connects R461 to the —25-volt supply and the emitter voltage starts negative. D461 is reverse biased, and the rate of fall is set by the time constant of R461-C461. Approximately 1 millisecond after Q465 emitter voltage starts negative, the Sweep Gating Multi switches so that Q465 is on and Q455 off. The sweep voltage runs up as described for 2 LINE operation.

The DISPLAY switch also changes the output of the Trigger Selector Matrix, forward biasing D452 through R450 so that positive pulses will come through D452, and will turn on Q455 to stop the sweep. The positive pulse that turns Q455 on occurs at every other vertical sync pulse. The sweep is stopped, runs down very rapidly due to additional rundown current from R455 in parallel with R468, waits 1 millisecond and automatically starts again, just before the video portion of the next field.

In the event vertical input composite video stops, the sweep will continue to cycle, but instead of positive pulses stopping the sweep, Q455 is turned on by sweep voltage feedback through R491-R492 in the same manner as described for 2 line operation. Thus, the Type 529 Monitor will show a sweep without vertical information when the DISPLAY switch is set to 2 FIELD, but requires a trigger signal for the sweep to operate in all other positions of the DISPLAY switch.

With the INPUT switch set to CAL, R469 is placed in parallel with R468 so the rundown rate will be rapid enough to prepare the sweep to run again at the next calibrator signal transition. This assures a cleanly triggered Calibrator display without the possible jitter caused by a longer rundown.

The runup rate of the Miller Runup circuit is slowed by adding C483 across the timing capacitor used in 2 LINE operation. C483 does not affect the sweep voltage peak value, but changes only the rate at which the spot moves across the crt. Television systems with different time per field than the 30-hertz U.S.A. rate require a change in the value of C483 to change the sweep rate. For longer time per field, increase C483 value; for less time per field, decrease C483 value. Modification of C483 is normally made at the factory at time of purchase.

The Miller Runup circuit drives both the Horizontal Amplifier and the Staircase Amplifier.

Unblanking Amplifier

The Unblanking Amplifier (Q474) responds to the Sweep Gating Multi (Q465) collector signal. When there is no sweep, the crt beam is pulled away from the deflection plates and phosphor screen, preventing any spot from being seen. Q474 collector is near ground at the time of no sweep, turning off the crt beam. As the Sweep Gating Multi switches states to start a sweep, Q474 is biased to cutoff and its collector rises to +101 volts, limited by conduction of D474 and D475.

The Unblanking Amplifier provides two more output signals during delayed sweep operation. One is the video output intensification discussed with the Vertical Amplifier description. The other is to increase the crt beam current to intensify the crt trace for the short duration of the delayed sweeps.

The collector signal of Q474 does not pull down on the trace intensification line; rather, that line is pulled down by R476 and the —5 volts of the Video Output Amplifier circuit between sweeps when the DISPLAY switch is set to either Delayed position. The collector voltage of Q474 is near ground most of the time in delayed modes, because of the short-duration sweeps recurring at a 30-hertz rate (once every 33.3 ms). The trace intensification line (at R477-R478 junction) drops to —5 volts in about 2.6 ms as the combination of R476-R477 discharges C478 and changes the charge on C477.

As the sweep starts, Q474 collector rises quickly, sending an integrated pulse to the crt grid circuit. R478 permits the step to rise abruptly to +22 volts, then continue to rise at an rc rate. The rising signal to the crt grid is required to keep the cathode current constant during the intensification period assuring a uniform crt intensity throughout each sweep.

R476 also conducts current into the 75 ohms of the VIDEO OUTPUT connector, adding about 0.1 volt to the video output to intensify a line of the studio monitor, identifying which line the Type 529 Monitor is viewing.

HORIZONTAL AMPLIFIER

The Horizontal Amplifier circuit includes the Horizontal Amplifier and the Staircase Amplifier.

Horizontal Amplifier. The Horizontal Amplifier is a combination of feedback and paraphase amplifier. The base of Q533 is the virtual ground summing input terminal to the whole amplifier. Voltage gain of the overall amplifier is the ratio of the MAG resistance to the input resistance of R520. The dc level of the output (positioning) is through R525 to the base of Q533. The input to a feedback amplifier can have several input resistors and signals. The gain of each is the ratio of feedback resistor to input resistor. Feedback is from V554A cathode to the base of Q533. V554A cathode is also the signal source for the inverting half of the amplifier, through the HORIZ GAIN control R558-R568 to the base of Q574. Feedback in the inverting half of the amplifier is the cathode resistance of V554B to the base of Q574. The SWP/MAG REGIS control sets the dc balance of cathode voltages of V554A-V554B so the display center does not shift as the MAG switch is changed.

The sweep sawtooth enters through R520. Q533 is an emitter follower and current-gain transistor, driving the inverting amplifier Q544. Q544 signal output receives current gain in the cathode of V554A assuring linear feedback from a low impedance. The plate of V554A provides a +150-volt swing that would be impossible to achieve with transistors. It acts in a normal vacuum tube fashion, with the input grid signal appearing inverted at the plate output.

The HORIZ GAIN resistance is degenerative to V554A, and is the signal coupling path to Q574. The signal from V554A cathode to Q574 base runs negative, increasing the current in Q574 collector. The collector voltage of Q574 becomes less negative and drives the grid of V554B to increase V554B current, raising the cathode to the level it had before the signal started negative. Note that the base of Q574 acts as a virtual ground for signals. V554B grid swings about 6.6 volts, turning on plate current so the plate swings about —150 volts.

Staircase Amplifier

V514 is a feedback amplifier with two input resistors to sum the sawtooth and studio color-camera staircase voltages. When 25 volts is applied between pins D and E of J501, K501 causes R516 to become the third input to the Horizontal Amplifier. V514 inverts the sawtooth voltage so that the summed sawtooth signal to Q533 base is one-fourth its normal amplitude. The external input negative staircase signal is also inverted by V514.

With the staircase most positive, the sweep runs for the period of 1 field, and is reverted by a vertical sync trigger. At the time the sweep is reverted, the staircase drops negative to its second level. The sweep starts again, but begins one-fourth of the way across the crt due to the staircase positioning signal. Again the sweep runs for 1 field, is reverted and the staircase drops to its third level. Once again the sweep starts, but one-half of the way across the crt. Again the sweep runs for 1 field, is reverted and the staircase drops to its fourth level. Once again the sweep starts, but three-fourths of the way across the crt. Thus, the three-color and black-white camera signals can all be viewed in one crt display.

The staircase level shift takes about 800 μs. With the Sweep Gating Multi operating in 2 FIELD the sweep restarts in about 1 millisecond, so the change in staircase is not seen because the crt beam is blanked off at the same time.

Closing the staircase relay also changes the timing resistor of the Sweep Generator so the sweep rate is twice as fast as that for 2 FIELD operation. The relay also changes the operation of the Field Selector to put out a positive pulse at each vertical sync pulse time instead of at every other one. Thus, the sweep recurs at a 60-hertz rate, taking four sweeps to get across the crt.

POWER SUPPLY

The low-voltage Power Supply provides regulated —25 volts, +100 volts, and unregulated +360 volts to the circuits of the Type 529. The —25-volt supply is the reference voltage for the +100-volt supply and the Calibrator circuit.

The Type 529 is powered by a dual primary power transformer for operation on either 115 or 230 volt 50-60 hertz line. Refer to the Operating Instructions section of this manual for converting from one supply voltage to the other.

—25-Volt Supply

Voltage for the —25-volt power supply comes from the full-wave rectifier system of D610-D611 and C610. Voltage across C610 is nominally 35 volts.

The —25-volt regulator consists of a comparator that compares a portion of —25 volts (divided by R624-R626 and the —25 VOLTS/CAL AMPL control R620) against the voltage of a precision Zener diode D614. D614 Zener voltage is about —9.1 volts. The comparator output at Q616 collector is inverted and amplified by Q634, which drives the series transistor Q637 in a direction to compensate for changes in the output voltage.

Assume the —25-volt decreases and the voltage goes slightly positive. Q626 turns on harder, reducing the current in Q616 so its collector goes positive. Q634 turns on harder and pulls Q637 base in the negative direction, causing it to conduct harder, raising the output voltage back to its proper negative level. Since the collector of Q637 is grounded, the whole supply is moved by the emitter of Q637 to make the correction. R617-C617 at the base of Q634 reduce the feedback loop high-frequency gain for more stable operation with high-frequency load transients. C620 and C626 aid in reducing the high-frequency output impedance of the supply.

The —25-volt supply is the voltage source for the heaters of V113 and V293. R621 across V293 heater compensates the heater voltage for current taken by the Constant Current stage of the Vertical Preamplifier.

The value of the —25-volt supply directly sets the peak-to-peak amplitude of the Calibrator signal; therefore, the control used to adjust the supply is labeled —25 VOLTS/CAL AMPL. See the Calibration procedure for adjustment.

+100-Volt Supply

Voltage for the +100-volt supply is provided by the full-wave bridge rectifiers D640A-B-C-D and C640. The voltage across C640 is nominally 130 volts.

The +100-volt regulator compares a portion of the +100 volts (referenced to the —25-volt supply through the divider R641-R642) to ground at the emitter of Q644. Q643 is an emitter follower acting as an impedance transfer device to raise the base impedance of Q644 base to prevent loading the divider. Q644 amplifies and inverts any change at the base of Q643 and applies the change directly to the base of Q647. Q644 collector current is the total base current of Q647. Q647 emitter voltage follows the inverted correction signals, changing the level of the whole supply when needed.

Assume that the load increases, taking the +100 volts slightly negative. Q643 drives Q644 base negative, increasing its collector current. Increased Q644 collector current means increased base current in Q647, raising the emitter positive the correct amount to restore the output voltage.

Fuse F648 protects Q647 for accidental short circuit of the +100-volt supply bus.

C649 and C644 aid in reducing the supply high-frequency impedance. R644 limits the peak current through C644 to the base of Q643 in case the supply is accidentally shorted.

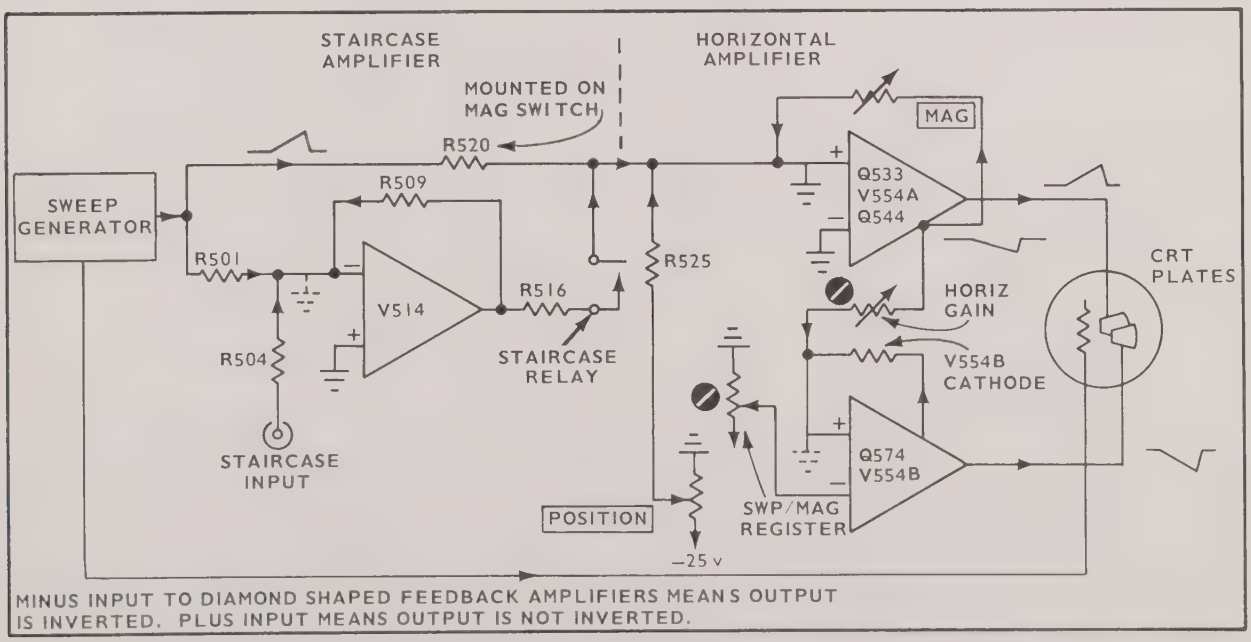

Fig. 3-11. Simplified Horizontal Amplifier.

R646-C646 decouple the +100-volt bus for peak current of the crt unblanking circuit.

+360-Volt Supply

Voltage for the +360-volt unregulated supply is provided by the full-wave bridge rectifiers D650A-B-C-D and C650A. The voltage across C650A is nominally 260 volts, which is added to the +100-volt supply. The supply is used by the crt high-voltage supply and the vertical output stage, whose current passes through the beam rotator coil.

Beam Rotator Coil. The rectangular crt is not easily rotated physically. Also, the trace changes its alignment with the graticule slightly, depending upon the monitor's relation to the earth's magnetic field. Thus, a coil is included around the crt proper, allowing the operator to adjust the trace alignment with the graticule.

CRT CIRCUIT AND CALIBRATOR

The Type T5290 (V859) cathode-ray tube is a rectangular, flat-faced, mono-accelerator, deflection-blanked type, designed especially for the Type 529 Waveform Monitor. Acceleration voltage is 5500 volts with —5300 V at the cathode, and nominally +200 volts at the deflection plates. The phosphor is aluminized, permitting bright displays and preventing any chance of phosphor damage at any position of the INTENSITY control.

The beam is blanked between sweeps by special deflection plates (located in the focus gun area of the tube) that pull all electrons away from the screen. Special intensifying circuits described with the sweep generator automatically brighten selected line displays for easy viewing of fast sweeps at low-repetition rates.

The bias network consisting of R855, R856, and R857 insures uniform intensity of the CRT horizontal trace. This is accomplished by varying the voltage applied to the fixed unblanking plate.

High-Voltage Power Supply and Calibrator

High-Voltage Power Supply. The High-Voltage Supply is actually a cathode-modulated amplifier with positive feedback sustaining oscillation. The cathode modulation is voltage feedback from the high-voltage output that controls the level of oscillation. The calibrator transistor Q874 is directly in the feedback path that sustains oscillation.

As the monitor is turned on, V800B is turned off due to its cold heater. The voltage divider of R875-R876 turns on Q874 so its collector voltage is about —10 volts. Q874 collector is directly connected to the grid of V800B. V800B will conduct with its grid at —10 volts. As V800B warms up and pulls plate current, Q874 collector receives a transformer-coupled turn-off signal and its collector voltage turns on V800B even more. The secondary of T801 is a tank circir, resonant at about 30 kHz. Thus, Q874 first receives a turn-off pulse, and then as T801 secondary swings through a cycle, Q874 is turned on full, turning V800B completely off. The cycle of oscillation repeats, heating the cathodes of V822 and V832. As they conduct, high voltage is developed that soon reduces current in V800A and Q804 to limit the current of V800B. Any further changes in output high voltage will change the conduction level of V800B to correct and restore the supply voltage.

V822 and V832 are the diodes of a half-wave voltage doubler with C837 and C848, the main filter capacitors. C837 also couples fast output voltage changes to the control tube V800A.

The multiple-resistor bleeder of R834 through R847 also provides voltage division for the INTENSITY and FOCUS controls. C849 assures that there is not voltage ripple between the cathode and grid of the crt which would otherwise intensity-modulate the trace.

Neon bulbs placed across the ASTIG control assure that the voltage of the astigmatism element remains constant to the average voltage of the Vertical Deflection plates, which also use the unregulated +360-volt supply.

Calibrator. The calibrator voltage is a secondary benefit of the high-voltage oscillator. Q874 collector voltage swings between about ground and the —25-volt supply, providing a stable square wave. D881 sets the ground level, and the —25-volt supply sets the negative level. R881, R885 and R886 divide the 25-volt swing for use in the Vertical Amplifier when the VOLTS FULL SCALE control is at 1.0. As the gain of the Vertical Amplifier is increased with the VOLTS FULL SCALE switch, R882 and/or R883 reduce the calibrator output amplitude to keep the display on the crt screen.

External Calibrator signals see a 1-megohm load when the switch is set to EXT.

SECTION 4

MAINTENANCE

Visual Inspection

If trouble occurs in the Type 529, make sure the associated equipment is operating and the controls are properly set. If it is determined that the trouble is definitely in the Type 529, a visual check may reveal the cause. Defects such as loose or broken connections, frayed or broken cables, damaged connectors, burned components, and broken switches can generally be detected by a visual inspection. Except for heat-damaged components, the remedy for such defects is obvious. Overheating of components is usually a symptom of other, less apparent, troubles in the circuit. For this reason, it is essential to determine the actual cause of overheating before the damaged parts are replaced; otherwise, the damage may be repeated.

Parts Removal and Replacement

Whenever a part is replaced, check and adjust the instrument calibration as necessary. Most parts in the Type 529 can be replaced without detailed instructions. Some, however, are best removed and replaced by using definite procedures contained in the following paragraphs. (Parts ordering information is located on the back of the Abbreviations And Symbols page which immediately precedes Section 7 of this manual.)

CAUTION

Turn ac power off before removing tubes or transistors from their sockets.

Transistor Replacement. Transistors should not be replaced unless they are actually defective. Transistor defects usually take the form of the transistor opening, shorting, or developing excessive leakage. To check a transistor for these and other defects, use a transistor curve display instrument such as a Tektronix Type 575. However, if a good transistor checker is not readily available, a defective transistor can be found by signal-tracing, by making in-circuit voltage checks, by measuring the transistor forward-to-back resistance using proper ohmmeter resistances, or by using the substitution method. The location of all transistors is silk-screened on the chassis next to each socket.

To check transistors using a voltmeter, measure the emitter-to-base and emitter-to-collector voltages and determine if the voltages are consistent with the normal resistances and currents in the circuit (see Fig. 4-1).

To check a transistor using an ohmmeter, know your ohmmeter ranges, the currents they deliver, and the internal battery voltages(s). If your ohmmeter does not have sufficient resistance in series with its internal voltage source, excessive current will flow through the transistor under test. Excessive current and/or high internal source voltage may permanently damage the transistor.

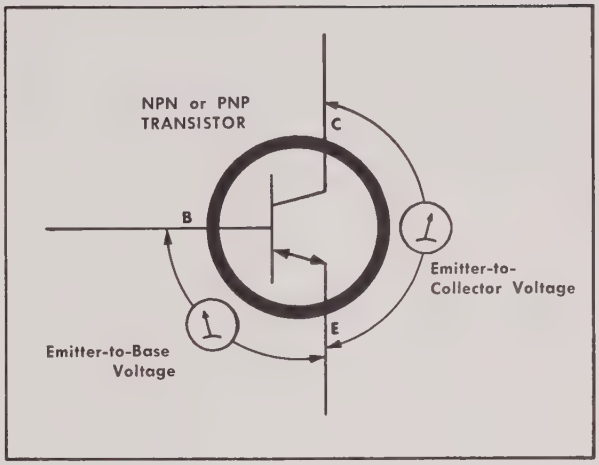

Fig. 4-1. In-circuit voltage checks NPN or PNP transistors.

NOTE

As a general rule, use the RX1k range where the current is usually limited to less than 2 mA and the internal voltage is usually 1½ volts. You can quickly check the current and voltage by inserting a multimeter between the ohmmeter leads and measuring the current and voltage for the range you intend to use.

When you know which ohmmeter ranges will not harm the transistor, use those ranges to measure the resistance with the ohmmeter connected both ways as given in Table 4-1.

TABLE 4-1

Transistor Resistance Checks

Ohmmeter Connections[1]	Resistance Readings That Can Be Expected Using the RX1k Range
Emitter-Collector	High readings both ways (about 60 kΩ to around 500 kΩ).
Emitter-Base	High reading one way (about 200 kΩ or more). Low reading the other way (about 400 Ω to 2.5 kΩ).
Base-Collector	High reading one way (about 500 kΩ or more). Low reading the other way (about 400 Ω to 2.5 kΩ).

[1]Test prods from the ohmmeter are first connected one way to the transistor leads and then the test prods are reversed (connected the other way). Thus, the effects of the polarity reversal of the voltage applied from the ohmmeter to the transistor can be observed.

If there is doubt about whether the transistor is good or not, substitute a new transistor; but, first be certain the circuit voltages applied to the transistor are correct before making the substitution.

When checking transistors by substitution, be sure that the voltages and loads on the transistor are normal before making the substitution. If a transistor is substituted without first checking out the circuit, the new transistor may immediately be damaged by some defect in the circuit.

Replacement of either Q637 or Q647 requires removal of only the transistor mounting bolts.

Remove the mounting bolts and pull the transistor and its leads a short distance away from the rear panel. Note the wire color code for correct resoldering to the leads of the new transistor. Unsolder the defective transistor. Wipe a small amount of non-melting silicon grease such as Dow Corning 4 Compound on the under side of the new transistor.

WARNING

Silicone grease will irritate and may damage eye tissues. Wash your hands throughly after this procedure before touching the face.

Solder the leads to the new transistor using long-nose pliers on the transistor lead as a heat sink. Push the transistor into place making sure the leads are separated, and re-install the mounting bolts. Wipe excess silicone grease away from the transistor edge with a disposable tissue.

Tube Replacement. Tester checks on tubes used in the Type 529 are not recommended. Tube testers sometimes indicate a tube to be defective when that tube is operating satisfactorily in a circuit, or they may fail to indicate tube defects which affect the performance of the circuits. The criterion for the usability of a tube is whether or not it works properly in the circuit. If it does not, it should be replaced. Unnecessary replacement is not only expensive, but may also cause needless recalibration of the instrument.

Lamp Replacement. The graticule illumination lamps are bayonet Type 47, 6-8 volt bulbs. Remove the four bezel nuts, lift away the graticule, and replace the lamps in the normal manner.

The three neon bulbs just to the left and the one below the crt (two are not visible through the front panel) are soldered in place. Removal and replacement require a small iron and long-nose pliers.

Recalibration

To assure accurate measurements, check the calibration of this instrument after each 500 hours of operation or every six months if used intermittently. Complete calibration instructions are given in Section 6.

The calibration procedure can also be helpful in localizing certain troubles in the instrument. In some cases, recalibration may reveal and correct minor troubles that do not show up during regular operation.

Cleaning

The Type 529 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation. It also provides a possible electrical conduction path.

Loose dust accumulated on the outside of the Type 529 can be removed with a cloth or small paint brush. The paint brush is particularly useful for dislodging dust on and around the front-panel controls. Dirt which remains can be removed with a soft cloth dampened in a mild solution of water and detergent. Abrasive cleaners should not be used.

The high-voltage circuits, including parts located under the high-voltage shield, should receive special attention. Excessive dust and dirt in these areas may cause high-voltage arcing and result in improper instrument operation.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Some chemicals to avoid are benzene, toluene, xylene, acetone, or similar solvents.

To clean the graticule and the face of the crt, first remove the four graticule nuts. Then remove the bezel and the graticule. Clean the graticule and the face of the crt with a soft, lint-free cloth dampened with mild detergent and water. Repeat with a cloth dampened with water only.

Standard Parts

All electrical and mechanical part replacements for the Type 529 can be obtained through your local Tektronix Field Office or representative. However, since many of the components are standard parts, they can generally be obtained locally in less time than from the factory. Before purchasing replacement parts, consult the Parts Lists for value, tolerance rating and Tektronix Part Number.

Special Parts

In addition to the standard components some special parts are used in the production of the Type 529. These parts are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix, Inc. in accordance with our specifications. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your Tektronix Field Office or representative. Parts ordering information is located on the Abbreviations And Symbols page which immediately precedes Section 7.

Resistor Coding

The Type 529 uses a number of very stable metal-film resistors identified by their gray background color and color coding.

If the resistor has three significant figures with a multiplier, the resistor will be EIA color coded. If it has four significant figures with a multiplier, the value will be printed on the resistor. For example, a 333-kΩ resistor will be color coded, but a 333.5-kΩ resistor will have its value printed on the resistor body.

The color-coding sequence is shown in Fig. 4-2.

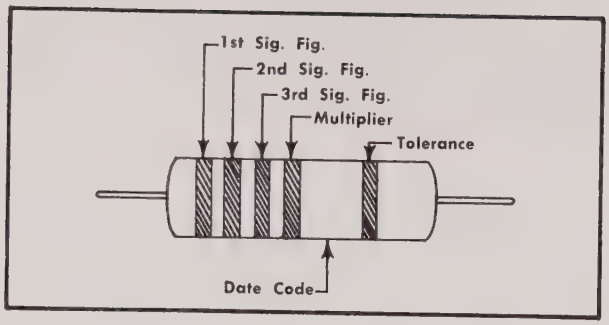

Fig. 4-2. Standard EIA color code for metal-film resistors.

Ceramic Terminal Strip Replacement

A complete ceramic terminal strip assembly is shown in Fig. 4-3. Replacement strips (including studs) and spacers are supplied under separate part numbers. The old spacers may be re-used unless they are damaged.

After the damaged strip has been removed, place the undamaged spacers in the chassis holes. Then, carefully press the studs into the spacers until they are completely seated. If necessary, use a soft mallet and tap lightly, directly over the stud area of the strip.

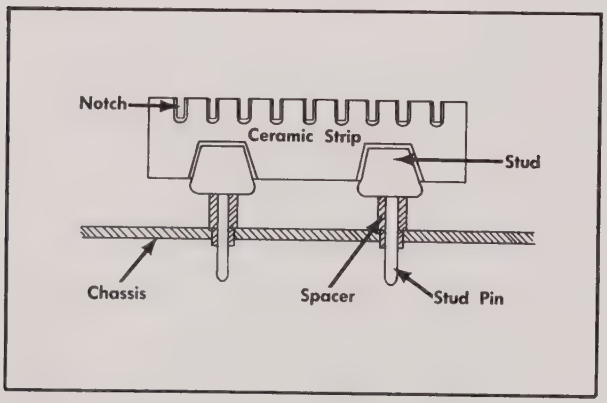

Fig. 4-3. Ceramic terminal strip assembly.

Soldering

Ceramic Terminal Strips. Solder used on the ceramic terminal strips should contain about 3% silver. Ordinary 60/40 solder can be used occasionally without damage to the ceramic terminal strips. Use a 40- to 75-watt soldering iron with a ⅛ inch wide chisel-shaped tip. If ordinary solder is used repeatedly, or if excessive heat is applied, the solder-to-ceramic bond can be broken.

A small supply of solder containing about 3% silver is included on a spool mounted inside this instrument on the rear panel. Additional solder should be available locally, or it can be purchased from Tektronix in one-pound rolls; order by Tektronix Part No. 251-0514-00.

Observe the following precautions when soldering ceramic terminal strips:

1. Use a hot iron for a short time. Apply only enough heat to make the solder flow freely.

2. Maintain a clean, properly tinned tip.

3. Avoid putting pressure on the ceramic terminal strip.

4. Do not attempt to fill the terminal-strip notch with solder; use only enough solder to cover the wires adequately.

Metal Terminals. When soldering to metal terminals (e.g., switch terminals, potentiometers, etc.), ordinary 60/40 solder can be used. The soldering iron should have a 40- to 75-watt rating with a ⅛ inch wide chisel-shaped tip.

Observe the following precautions when soldering to metal terminals:

1. Apply only enough heat to make the solder flow freely.

2. If a wire extends beyond the solder joint, clip the excess wire close to the joint.

3. Apply only enough solder to form a solid connection. Excess solder may impair the function of the part.

Rotary Switches

Individual wafers or mechanical parts of rotary switches are normally not replaced. If a switch is defective, replace the entire assembly. The availability of replacement switches, either wired or unwired, is detailed in the Parts List.

Cathode-Ray Tube

Use the following procedure for removal and replacement of the crt:

WARNING

Use care when handling a crt. Avoid striking it on any object that might cause it to crack and implode. Flying glass from an imploding crt can cause serious injury. Wear safety glasses or a plastic face mask.

1. Disconnect the instrument power.

2. Place the instrument on a level workbench.

3. Remove the graticule.

4. Carefully remove the five neck leads. Use long-nose pliers and slowly pull each clip off its neck pin.

5. Loosen the 6-32 bolt in the white plastic crt rear neck clamp.

6. Place one hand over the crt face. With the other hand push gently on the crt socket until the tube moves slightly forward. Remove the socket and push on the center of the crt base. Carefully guide the tube out the front, so as to not touch the magnetic shield with the neck pins.

To install a new crt:

1. Position the tube with the single neck pin at the top, two neck pins at both the side and bottom.

2. Carefully insert the tube into the magnetic shield, being careful not to touch the shield with the neck pins.

3. Extend the finger of one hand into the rear end of the shield to help guide the base into place. Push the crt the last ¼ inch with the plastic graticule so the front of the tube is flush with the front panel.

4. Tighten the 6-32 bolt in the plastic clamp until the crt neck is held firmly. DO NOT OVERTIGHTEN.

5. Use long-nose pliers and carefully install the neck clips to the neck pins; observe the color code as marked on the shield near each opening.

6. If the crt face is not parallel with the front panel, use a $\frac{7}{64}$-inch hexagonal wrench to loosen the two hexagonal headed bolts at the mounting clamp. Raise, lower, or otherwise position the crt socket so the face is correctly positioned. Tighten the hexagonal headed bolts and check that the neck pins are not grounded.

7. Re-install the graticule and recalibrate the instrument in accordance with the Calibration procedure.

Troubleshooting

In the event of trouble, help with the particular problem may be obtained by reading the Circuit Description. Voltage checks and normal troubleshooting procedures will aid in finding and correcting the trouble.

Power-Supply Problems. The Type 529 can still preset a display and appear to operate if certain problems develop in the power supplies. The following table of symptoms and their related causes may help solve power-supply failures.

TABLE 4-3

Problem	Probable Cause
1. Short sweep, excess high voltage and ripple horizontally.	Q647 or Q644 of +100-volt supply is shorted.
2. Same as No. 1; in addition, Calibrator waveform shows considerable hum.	Q637 or Q634 of —25-volt supply is shorted.
3. No trace. No heater glow in two 12AT7 tubes. Power On neon still glows.	Q637 or Q634 of —25-volt supply is open or F637 is blown. Or if 12AT7 heaters glowing, V833-V832 filaments open; look for their glow.
4. Sweep shortens as INTENSITY control is turned clockwise.	V800A has a short, or V800B has a short, or Q804 is shorted.

SECTION 5

PERFORMANCE CHECK

Introduction

This section of the manual provides a means of rapidly checking the performance of the Type 529. It is intended to check the calibration of the instrument without the need for performing the complete Calibration Procedure. The Performance Check does not provide for the adjustment of any internal controls. Failure to meet the requirements given in this procedure indicates the need for internal checks or adjustments, and the user should refer to the Calibration Procedure in this manual.

EQUIPMENT REQUIRED

General

The following equipment, or its equivalent, is required for a complete preformance check of the Type 529. Specifications given are the minimum necessary to accurately check the performance of this instrument. All test equipment is assumed to be correctly calibrated and operating within the original specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

Special Test Equipment

For the quickest and most accurate calibration, special calibration fixtures are used where necessary. All calibration fixtures listed under Equipment Required can be obtained from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Constant amplitude sine-wave generator. Frequency, 500 kHz and 350 kHz to above 10 MHz; output amplitude, 200 mV to 1 volt adjustable; ampliude accuracy, ±3% at 50 kHz and 350 kHz to above 10 MHz. Tektronix Type 191 recommended.

2. Test oscilloscope. Bandpass, dc to 1 MHz; minimum deflection factor, 0.005 volts/division. Tektronix Type 545B Oscilloscope with Type B Plug-In Unit, and Tektronix P6006 and P6028 Probes recommended.

3. Standard amplitude calibrator. Amplitude accuracy, within 0.25%; signal amplitude, 0.2 volt to 2 volts; output frequency, 1 kHz. Tektronix calibration fixture 067-0502-00 recommended.

4. Time-mark generator. Marker outputs of 1 μs, 5 μs, 10 μs, 0.1 ms and 0.1 μs; accuracy, 0.001%. Tektronix Type 184 recommended.

5. Composite video signal source. Calibrated signal amplitude of 1 volt, variable from 200 mV to 1 volt. For example, Conrac model AU 12C receiver.

6. Square-wave generator. Frequency of 120 hertz; output amplitude variable from 4 to 12 volts. Tektronix Type 105, Type 106, or equivalent.

7. Termination. Impedance, 75 ohms; accuracy, ±3%; connector, UHF. Tektronix Part No. 011-0046-00.

8. Three cables. Impedance, 75 ohms; type RG 11/U; length 42 inches; connectors, BNC. Tektronix Part No. 012-0074-00.

9. Two adapters. Connectors, BNC jack to UHF plug. Tektronix Part No. 103-0015-00.

10. One capacitor. 2 μF at 150 WVDC. Tektronix Part No. 290-0121-00.

PERFORMANCE CHECK PROCEDURE

General

In the following procedure, test equipment connection or control settings should not be changed except as noted. If only a partial check is desired, refer to the preceding step(s) for setup information.

The following procedure uses the equipment listed under Equipment Required. If substitute equipment is used, control settings or setup must be altered to meet the requirements of the equipment used.

Preliminary Procedure

1. Remove from any enclosure, to provide access to rear-panel connectors.

2. Check that a 160-IEEE unit 7-cm composite graticule (331-0161-00) is installed and that the VIDEO OUTPUT connector is terminated into 75 Ω.

3. Connect the Type 529 power cord to a suitable power source.

4. Set the Type 529 POWER and SCALE ILLUM switch to on. Allow at least 20 minutes warm up, for checking the instrument to the given accuracies.

POWER and SCALE ILLUM	Fully clockwise
FOCUS	Midrange
INTENSITY	Fully counterclockwise
GAIN	As is
VERTICAL Controls	
RESPONSE	FLAT
DC RESTORER	OFF
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	EXT
POSITION	Midrange
HORIZ Controls	
POSITION	Midrange
SYNC	INT

MAG	×1
DISPLAY	2 FIELD
FIELD	ONE
VARIABLE (Line Selector)	Midrange
LINE SELECTOR Switch	VARIABLE

1. Check Graticule Illumination

a. Requirement—Graticule illumination must be maximum when the POWER and SCALE ILLUM control is fully clockwise. There should be an illumination when the POWER and SCALE ILLUM control is fully counterclockwise, but not switched into the AC OFF position. The graticule illumination must smoothly change intensity with smooth rotation of the POWER and SCALE ILLUM control.

b. With the POWER and SCALE ILLUM control fully clockwise, check for maximum graticule illumination.

c. Slowly and smoothly rotate the POWER and SCALE ILLUM control counterclockwise, but not into the AC OFF position, noting that the graticule illumination decreases smoothly as the control is rotated.

d. Check—Graticule illumination is minimum.

e. Adjust the POWER and SCALE ILLUM control for desired graticule illumination.

2. Check Crt Beam Rotator and Horizontal Geometry

a. Requirement—Crt Beam Rotator is adjustable for no horizontal tilt.

Horizontal Geometry. Trace bowing or trace deviation from a straight horizontal line must not exceed 2 mm.

b. Rotate the INTENSITY control clockwise until a trace can be seen.

c. Ground the upper VIDEO INPUTS A connector.

NOTE

The trace should be parallel to the horizontal graticule lines, but due to the different effects that the earth's magnetic field will have at various locations, it is impossible to state that the trace should be aligned within plus or minus a specific tolerance. If the traces are not parallel to the horizontal graticule lines, it will be necessary to adjust the internal CRT BEAM ROTATOR control until the trace is parallel to the horizontal graticule lines.

d. Position the start of the trace to the left edge of the graticule and vertically position the trace to the +30 IEEE units graticule line.

e. Check—Amount of trace bowing or deviation from a straight line.

f. Remove ground from upper VIDEO INPUTS A connector.

3. Check FOCUS and INTENSITY Controls

a. Requirement—Focus: The FOCUS control must adjust for a well-defined display without being at either end of its adjustment range.

Intensity: With the INTENSITY control fully counterclockwise there must be no display. Clockwise rotation of the control must increase the intensity smoothly with smooth rotation of the control.

b. Reset the following controls:

INPUT	CAL
CAL	.714 F. S.
DISPLAY	2 LINE

c. Adjust the FOCUS control for a well-defined display.

d. Check—FOCUS control should not be at either end of its adjustment range.

e. Rotate the INTENSITY control fully counterclockwise.

f. Check—No display.

g. Slowly and smoothly rotate the INTENSITY control clockwise.

h. Check—For a smooth and constant increase in display brightness.

i. Adjust the INTENSITY control for normal display brightness.

4. Check Vertical Geometry

a. Requirement—Vertical trace bowing and/or tilt must not exceed 2 mm.

b. Reset the following controls:

INPUT	A
SYNC	EXT
DISPLAY	.25 H/CM

c. Connect 5-μs time markers to the right VIDEO INPUTS A connector using a 75-ohm coaxial cable.

d. Connect a 75-ohm termination to the left VIDEO INPUTS A connector.

e. Connect .1-ms time-marker trigger pulses to the right EXT NEG SYNC INPUT connector using a 75-ohm coaxial cable.

f. Adjust the (VERTICAL) POSITION control and the VOLTS FULL SCALE switch and its VARIABLE control so the time markers over-scan the crt viewing area.

g. Check—For not more than 2 mm of bowing and/or tilt.

h. Disconnect the time markers from the right VIDEO INPUTS A connector and the time-marker trigger pulses from the right EXT NEG SYNC INPUT connector.

5. Check (VERTICAL) POSITION Control

a. Requirement—Range: POSITION control must be able to position the trace off the top and bottom of the graticule area.

Direction: Clockwise rotation of the control must move the trace up and counterclockwise rotation must move the trace down.

b. Reset the following controls.:

(VERTICAL) POSITION	Fully clockwise
SYNC	INT
DISPLAY	2 FIELD

c. Check—For upward trace movement beyond the graticule viewing area.

d. Rotate the POSITION control fully counterclockwise.

e. Check—For downward trace movement beyond the graticule limits.

6. Check Vertical Gain and Calibrator

a. Requirement—Vertical gain: 1.0 position; 1 volt of square wave from a standard amplitude calibrator must product 140 IEEE units of deflection, ±1%. 0.2 position; 0.2 volt of square wave from a standard amplitude calibrator must produce 140 IEEE units of deflection, ±2%. 0.5 position; 0.5 volt of square wave from a standard amplitude calibrator must produce 140 IEEE units of deflection, ±3%. VARIABLE (VOLTS FULL SCALE) ratio must be 2.5:1 or greater.

Calibrator: FULL SCALE; calibrator deflection must match (1 volt) standard amplitude calibrator deflection (140 IEEE units), ±1%. .714 F. S.; calibrator deflection must be 100 IEEE units, ±1%, when FULL SCALE setting of calibrator produces 140 IEEE units of deflection.

b. Connect 1-volt of standard amplitude calibrator square wave through a 75-ohm coaxial cable to the right VIDEO INPUTS A connector.

c. Set the VOLTS FULL SCALE switch to 1.0.

d. Check—For 140 IEEE units of deflection, ±1%.

e. Set the standard amplitude calibrator for a 0.5-volt square wave.

f. Set the VOLTS FULL SCALE switch to 0.5.

g. Check—For 140 IEEE units of deflection, ±3%.

h. Set the standard amplitude calibrator for a 0.2-volt square wave.

i. Set the VOLTS FULL SCALE switch to 0.2.

j. Check—For 140 IEEE units of deflection, ±2%.

k. Set the VOLTS FULL SCALE switch to 1.0.

l. Adjust the VARIABLE (VOLTS FULL SCALE) control so as to produce maximum signal deflection. Note the amount of deflection.

m. Adjust the VARIABLE (VOLTS FULL SCALE) control so as to produce minimum signal deflection. Note the amount of deflection.

n. Check— $\frac{\text{Maximum signal deflection}}{\text{Minimum signal deflection}}$ = a ratio of 2.5:1 or greater.

o. Reset the following controls:

VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	FULL SCALE

p. Set the standard amplitude calibrator for a 1-volt square-wave signal and note the signal amplitude.

q. Change the INPUT switch to CAL.

r. Check—That the calibrator signal amplitude matches the standard amplitude calibrator signal amplitude within 1%. Note any error.

s. Change the CAL switch to .714 F. S.

t. Check—That the calibrator signal amplitude is 100 IEEE units ±1%, taking into account any error noted in part r of this step.

7. Check External Calibrator Input

a. Requirement—1 volt of standard amplitude calibrator square-wave signal must produce 140 IEEE units of deflection, ±1%.

b. Remove the standard amplitude calibrator signal from the right VIDEO INPUTS A connector and connect it to the right EXT CAL INPUT connector.

c. Set the CAL switch to EXT.

d. Check—For 140 IEEE units of deflection, ±1%.

e. Reconnect the standard amplitude calibrator signal to the right VIDEO INPUTS A connector.

f. Set the INPUT switch to A.

8. Check Compression and Expansion

a. Requirement—Compression and expansion must not exceed one IEEE unit.

b. Change the standard amplitude calibrator to obtain a 0.2-volt square wave.

c. Using the VARIABLE (VOLTS FULL SCALE) and the (VERTICAL) POSITION controls, obtain a signal 40 IEEE units higher and center it vertically in the graticule area.

d. Position the top of the display to the top graticule line.

e. Check—for less than one IEEE unit of compression or expansion.

f. Position the bottom of the display to the bottom graticule line.

g. Check—For less than one IEEE unit of compression or expansion.

h. Return the VARIABLE (VOLTS FULL SCALE) control to CALIB.

i. Disconnect the standard amplitude calibrator.

9. Check DC RESTORER Switch

a. Requirement—Reference level must shift no more than ±4 IEEE units for a gain change within the graticule area.

b. Set the DC RESTORER switch to ON.

c. Connect a composite video signal to the right VIDEO INPUTS A connector.

d. Adjust the amplitude of the incoming composite video signal to obtain a display 30 IEEE units high.

e. Position the 0 IEEE signal level (back porch) to the 0 IEEE graticule line.

f. Rotate the VOLTS FULL SCALE switch through its 0.2 and 0.5 positions.

g. Check—Amount of vertical shift of the 0 IEEE signal level (back porch). It must not exceed ±4 IEEE units.

h. Set the VOLTS FULL SCALE switch to 1.0.

10. Check Horizontal Gain

a. Requirement—See Table 5-1.

TABLE 5-1

DISPLAY Switch	Trace Length	Tolerance
2 FIELD	10.2	±5%
2 LINE	10.2	±5%
.125 H/CM	10.2	±2%
.25 H/CM	10.2	±2%

b. Set the DISPLAY switch to each of the positions listed in Table 5-1.

c. Check—For a trace length within the tolerance listed in Table 5-1.

d. Set the DISPLAY switch to .125 H/CM.

e. Disconnect the composite video signal.

11. Check Horizontal Sweep Rates

a. Requirement—See Table 5-2.

TABLE 5-2

DISPLAY Switch	Mag Switch	Time Markers Applied	Markers per 10 Major Divisions	Tolerance
.125	×1	5 μs and 10 μs	8	±2%
.125	×5	1 μs	16	±3%
.125	×25	0.1 μs	32	±5%

b. Connect the output of a time-mark generator through a 75-ohm coaxial cable to the right VIDEO INPUTS A connector.

c. Connect 0.1-ms time-marker trigger pulses from the time-mark generator through a 75-ohm coaxial cable to the upper EXT NEG SYNC INPUT connector.

d. Set the SYNC switch to EXT.

e. Adjust the VOLTS FULL SCALE switch and the VARIABLE (VOLTS FULL SCALE) control to obtain a display 50 IEEE units high.

f. Set the time-mark generator and Type 529 controls as listed in Table 5-2.

g. Check—For the proper number of markers for 10 divisions within the tolerance listed in Table 5-2.

12. Check (HORIZONTAL) Position Control

a. Requirement—The trace must move to the right with clockwise rotation of the POSITION control. The trace must move to the left with counterclockwise rotation of the POSITION control.

b. Rotate the POSITION control to its fully clockwise position.

c. Check—That the trace moves to the right.

d. Rotate the POSITION control to its fully counterclockwise position.

e. Check—That the trace moves to the left.

f. Set the (HORIZ) POSITION control to midrange.

g. Disconnect the time-mark generator time markers and time-marker trigger pulses from the Type 529.

h. Reset the following controls:

SYNC	INT
DISPLAY	2 FIELD

13. Check FIELD Switch

a. Requirement—With the FIELD switch set to ONE, the last horizontal sync pulse will be one-half line (31.75 μs) away from the first equalizing pulse. With the FIELD switch set to TWO, the last horizontal sync pulse will be a full line (63.5 μs) away from the first equalizing pulse.

b. Connect a 1-volt composite video signal to the right VIDEO INPUTS A connector.

c. Reset the following controls:

DISPLAY	2 FIELD
MAG	×25
FIELD	ONE

d. If vertical sync pulse group is not completely displayed, position it to the horizontal center of the viewing area with the (HORIZ) POSITION control.

e. Check—The position (in time) of the last horizontal sync pulse before the first equalizing pulse. It should be 31.75.

f. Set the FIELD switch to TWO.

g. Check—The position (in time) of the last horizontal sync pulse before the first equalizing pulse. It should be 63.5.

14. Check Triggering

a. Requirement—Must trigger internally on a 200-mV peak-to-peak signal connected to the VIDEO INPUT connectors. Must trigger externally on a 250-mV peak-to-peak signal connected to the EXT NEG SYNC INPUT connectors.

b. Remove the composite video signal from the right VIDEO INPUTS A connector and connect it to the right EXT NEG SYNC INPUT connector.

c. Connect a 75-ohm coaxial cable from the left EXT NEG SYNC INPUT connector to the right VIDEO INPUTS A connector.

d. Reset the following controls:

VOLTS FULL SCALE	0.2
DISPLAY	2 FIELD

e. Adjust the amplitude of the composite video signal to obtain a display amplitude of 140 IEEE units on the crt.

f. Check—For a stable display on internal triggering.

g. Set the VOLTS FULL SCALE switch to 0.5.

h. Adjust the amplitude of the composite video signal to obtain a display amplitude of 70 IEEE units on the crt.

i. Set the SYNC switch to EXT.

j. Check—For a stable display on external triggering.

k. Reset the following controls:

VOLTS FULL SCALE	1.0
SYNC	INT
MAG	×25

l. Position the vertical sync block to the center of the graticule area.

15. Check Line Selector Operation (SN 998-up)

a. Requirement—Brighting pulse amplitude must be 100 mV or more.

NOTE

The start of the brighting pulse corresponds to the start of the sweep, as observed on the Type 529 CRT, while the width of the brighting pulse corresponds to the length of the sweep, as observed on the Type 529 CRT.

With the LINE SELECTOR switch set to VARIABLE and the LINE SELECTOR variable set fully counterclockwise, the brightening pulse must start in the vertical blanking time on or before the fifteenth line; with the LINE SELECTOR variable set fully clockwise, the brightening pulse must start after the first 25% of the second field; the display on the Type 529 must remain stable throughout the rotation of the LINE SELECTOR variable control.

With the LINE SELECTOR switch set to 16, the brightening pulse must start at the start of line 16; with the LINE SELECTOR switch set to 17, the brightening pulse must start at the start of line 17; with the LINE SELECTOR switch set to 18, the brightening pulse must start at the start of line 18; with the the LINE SELECTOR switch set to 19, the brightening pulse must start at the start of line 19; with the LINE SELECTOR switch set to 20, the brightening pulse must start at the start of line 20; with the LINE SELECTOR switch set to 21, the brightening pulse must start at the start of line 21.

b. Connect a 75 ohm coaxial cable from the VIDEO OUTPUT connector of the Type 529 to the vertical input connector of the test oscilloscope.

c. Set the test oscilloscope controls as follows:

Input Selector	AC
Volts/Div	0.02
Time/Div	2 ms
Triggering Mode	Adjusted for stable display
Trigger Slope	+ External

NOTE

The external triggering signal must be at the video field rate.

d. Set the Type 529 DISPLAY switch to LINE SELECTOR .125 H/CM and the LINE SELECTOR switch to VARIABLE.

e. Rotate the LINE SELECTOR variable control fully counterclockwise.

f. Check—The position (in time) and the amplitude of the brightening pulse on the test oscilloscope. The brightening pulse must be at least 100 mV high and its start should be on or before the 15th line.

g. Rotate the LINE SELECTOR variable control fully clockwise.

h. Check—The position (in time) and the amplitude of the brightening pulse on the test oscilloscope. The brightening pulse must be at least 100 mV high and its start must occur after the first 25% of the second field.

i. Set the LINE SELECTOR switch to each numbered line position.

j. Check—That the brightening pulse is at least 100 mV high and that it starts at the start of the line that the LINE SELECTOR swich is set to.

k. Set the FIELD switch to ONE and repeat parts d through j.

NOTE

LINE 10 starts at the first horizontal pulse following the last equalizing pulse in both fields (field one and two). Lines 16 through 21 can be found by counting forward from this point of reference.

16. Check Line Selector Operation (SN 100-997)

a. Requirement—Brightening pulse amplitude must be 100 mV or more. With the LINE SELECTOR control fully counterclockwise, the brightening pulse must start in the vertical blanking time before the sixteenth line. With the LINE SELECTOR control fully clockwise, the brightening pulse must start after the first 25% of the second field. The display on the Type 529 must remain stable throughout the rotation of the LINE SELECTOR control.

b. Connect a 75-ohm coaxial cable from the VIDEO OUTPUT connector of the Type 529 to the vertical input connector of the test oscilloscope.

c. Set the test oscilloscope controls as follows:

Input Selector	AC
Volts/Div	0.02
Time/Div	2 ms
Triggering Mode	Adjusted for stable display
Trigger Slope	+ EXT

NOTE

The external triggering signal must be at the video field rate.

d. Set the Type 529 DISPLAY switch to LINE SELECTOR .125 H/CM.

e. Rotate the LINE SELECTOR control fully counterclockwise.

f. Check—The position (in time) and the amplitude of the brightening pulse on the test oscilloscope. The brightening pulse must be at least 100 mV high and its start should be before the sixteenth line.

g. Rotate the LINE SELECTOR control fully clockwise.

h. Check—The position (in time) and the amplitude of the brightening pulse on the test oscilloscope. The brightening pulse must be at least 100 mV high and its start must occur after the first 25% of the second field.

i. Remove all connections to the Type 529.

17[1]. Check Frequency Response

a. Requirement—See Table 5-3.

TABLE 5-3

Response Switch Set to:	VARIABLE (VOLTS FULL SCALE) Set to:	VOLTS FULL SCALE Set to:	Check or Procedure
FLAT	CALIB	1.0	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.
FLAT	CALIB	1.0	Check for flat frequency response from 50 kHz to 6 MHz; within +0%, —1% (—0.1 dB) or 1 IEEE unit.
FLAT	CALIB	1.0	Check for flat frequency response from 6 MHz to 8 MHz; within +0%, —3% (—0.3 dB) or 3 IEEE units.
FLAT	CALIB	0.2	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.
FLAT	CALIB	0.2	Check for flat frequency response from 50 kHz to 6 MHz; +0%, —1% (—0.1 dB) or 1 IEEE unit.
FLAT	CALIB	0.5	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 500 kHz.
FLAT	CALIB	0.5	Check for flat frequency response from 500 kHz to 6 MHz; +0%, —1% (—0.1 dB) or 1 IEEE unit.
FLAT	Counterclockwise	1.0	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.
FLAT	Counterclockwise	1.0	Check for flat frequency response from 50 kHz to 6 MHz; +0%, —2% (—0.2 dB) or 2 IEEE units.
LOW PASS	CALIB	1.0	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.
LOW PASS	CALIB	1.0	Check for 20 IEEE units (down 14 dB) or less of deflection at 500 kHz.
FLAT	CALIB	1.0	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 3.58 MHz of deflection.
HIGH PASS	CALIB	1.0	Check for 100 IEEE units +0%, —1% (—0.1 dB) (1 IEEE unit) for deflection at 3.58 MHz.
HIGH PASS	CALIB	1.0	Check for 65 to 85 IEEE units of deflection at 3.18 MHz.
HIGH PASS	CALIB	1.0	Check for 65 to 85 IEEE units of deflection at 3.98 MHz.
IEEE	CALIB	1.0	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.
IEEE	CALIB	1.0	Check for 94 to 97.5 IEEE units of deflection at 350 kHz.
IEEE	CALIB	1.0	Check for 70 to 80 IEEE units of deflection at 1 MHz.
IEEE	CALIB	1.0	Check for 31.2 to 42.5 IEEE units of deflection at 2 MHz.
IEEE	CALIB	1.0	Check for 5.6 to 14 IEEE units of deflection at 3.6 MHz.

[1]An optional method of checking high-frequency response of the vertical amplifier will be found in step 18.

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b. Connect the output of a constant amplitude sine-wave generator through a 75-ohm coaxial cable to the right VIDEO INPUTS A connector.

c. To the left VIDEO INPUTS A connector, connect a 75-ohm termination.

d. Set the Type 529 controls and apply the indicated signal frequencies as listed in Table 5-3.

e. Check—For the required amount of deflection as listed in Table 5-3.

f. Remove all connection to the Type 529.

18. Check J501 Staircase Input

a. Requirement—Four displays per ten centimeters. Each display should have some separation from neighboring displays.

b. Wire the 9-pin plug connector (Tektronix Part No. 134-0049-00) as shown in Fig. 5-1. Make sure that the 2-μF capacitor is in series between the Type 529 J501 connector pin C and the output of the square-wave generator.

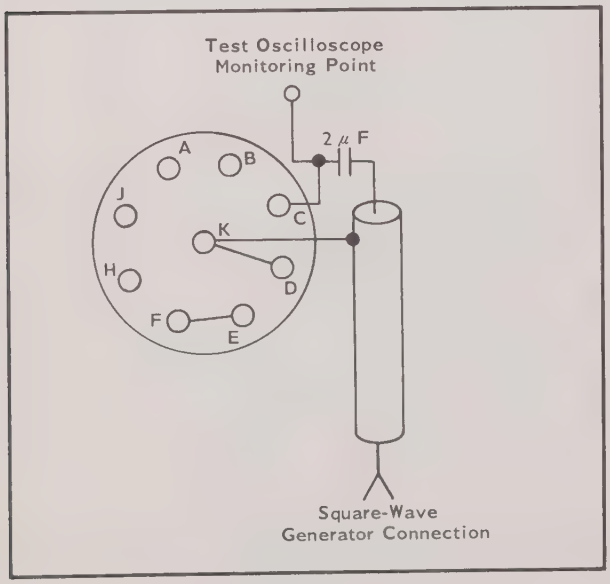

Fig. 5-1. Front view of 9-pin plug connector (Tektronix Part No. 134-0049-00) showing jumper wire connections to cause relay K501 to be energized whenever the plug is in place.

c. Connect the plug to J501 on the Type 529.

d. Connect a 12-volt, 120-hertz signal from a square-wave generator to pin C of the plug via the 2-μF capacitor.

e. Connect a test oscilloscope to the monitoring point to measure the output amplitude of the square-wave generator.

f. Apply one volt of composite video to the right VIDEO INPUTS A connector.

g. Connect a 75-ohm termination to the left VIDEO INPUTS A connector.

h. Check—For a display as shown in Fig. 5-2a. Note right-hand display position.

i. Reduce the signal from the square-wave generator to 8 volts.

j. Check—For a display as shown in Fig. 5-2b. Note right-hand display position.

k. Reduce the signal from the square-wave generator to 4 volts.

l. Check—For a display as shown in Fig. 5-2c. Note right-hand display position.

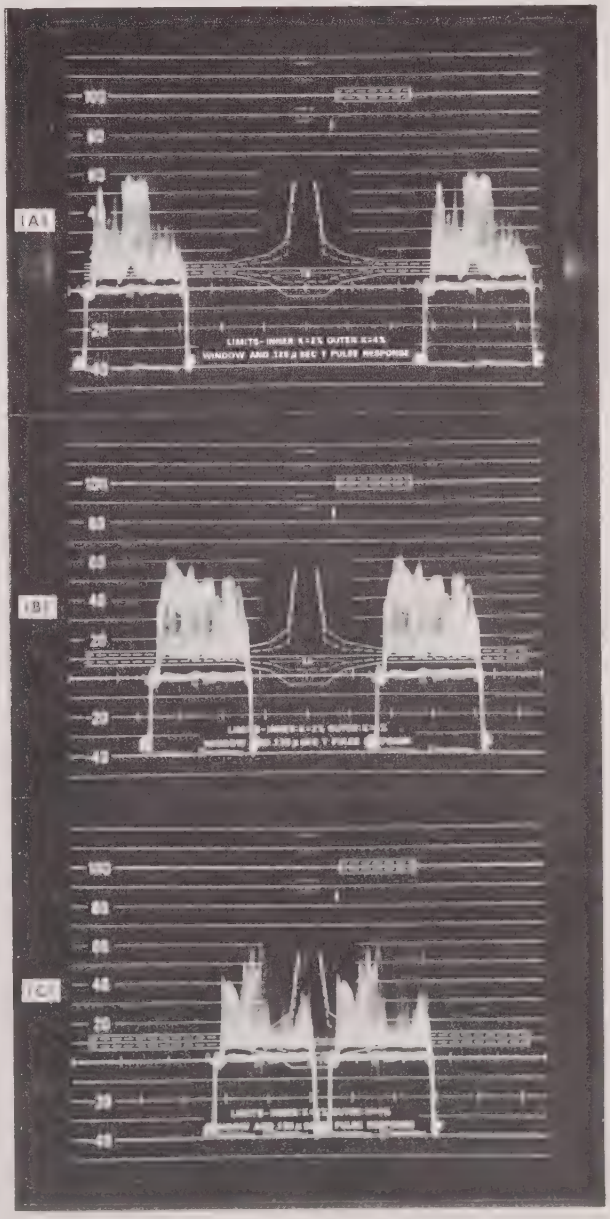

Fig. 5-2. Checking to insure that four displays per 10 centimeters can be obtained.

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m. Check—That each display had some separation from its neighbors.

19. (Option Method) Check Frequency Response

a. Set the Type 529 front-panel controls as follows:

POWER and SCALE ILLUM	⅔ clockwise
FOCUS	Midrange
INTENSITY	Adjusted for normal display brightness
GAIN	Midrange

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	ON
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F. S.
POSITION	Midrange

HORIZ Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	.125 H/CM
FIELD	ONE
VARIABLE (Line Selector)	Midrange
LINE SELECTOR Switch	VARIABLE

b. Connect to right VIDEO INPUTS A connector 1-volt of multi-burst signal.

c. Connect a 75-ohm termination to the left VIDEO INPUTS A connector.

d. Check each position of the RESPONSE switch for the display shown in Fig. 5-3.

This completes the performance check procedure for the Type 529. Disconnect all test equipment. If the instrument has met all performance requirements given in this procedure, it is correctly calibrated and within the specified tolerances.

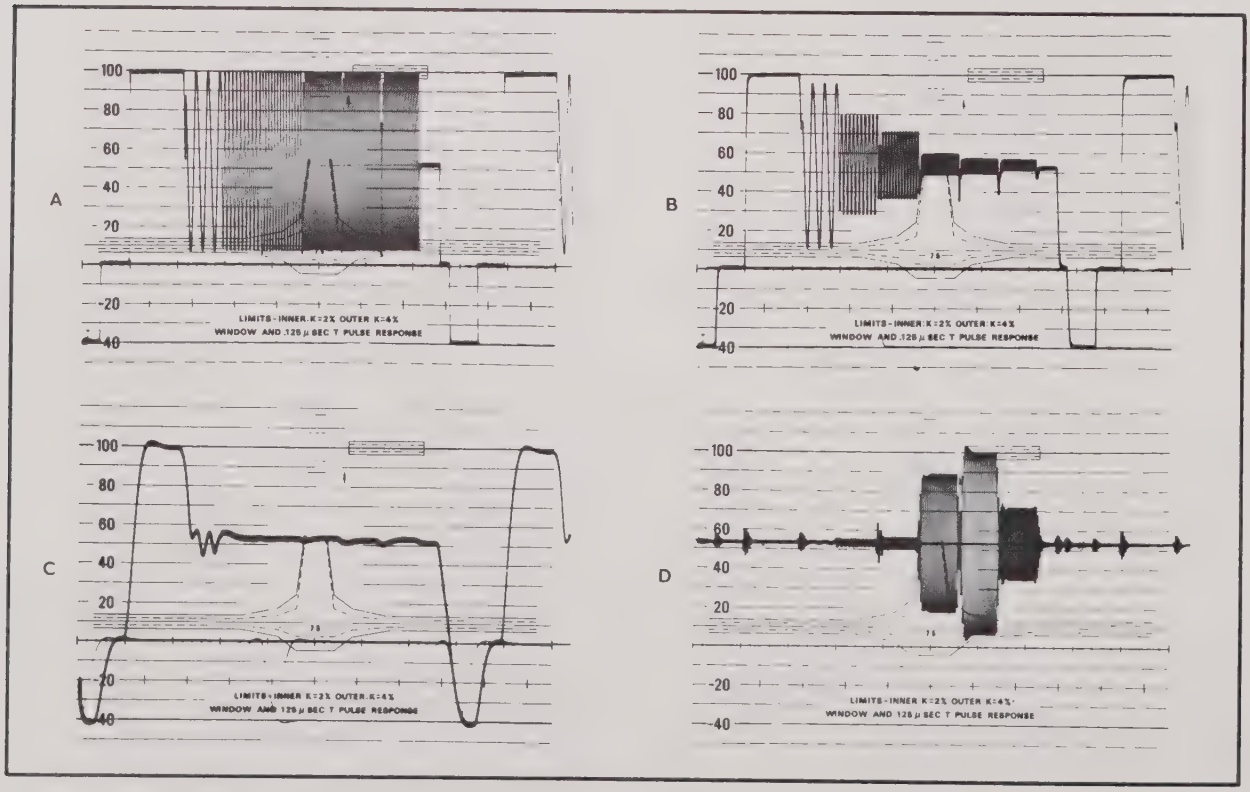

Fig. 5-3. Waveforms showing the display which will result when 1-volt of multi-burst signal is connected to the Type 529 and the RESPONSE switch is set to (A) FLAT, (B) IEEE, (C) LOW PASS, (D) HIGH PASS.

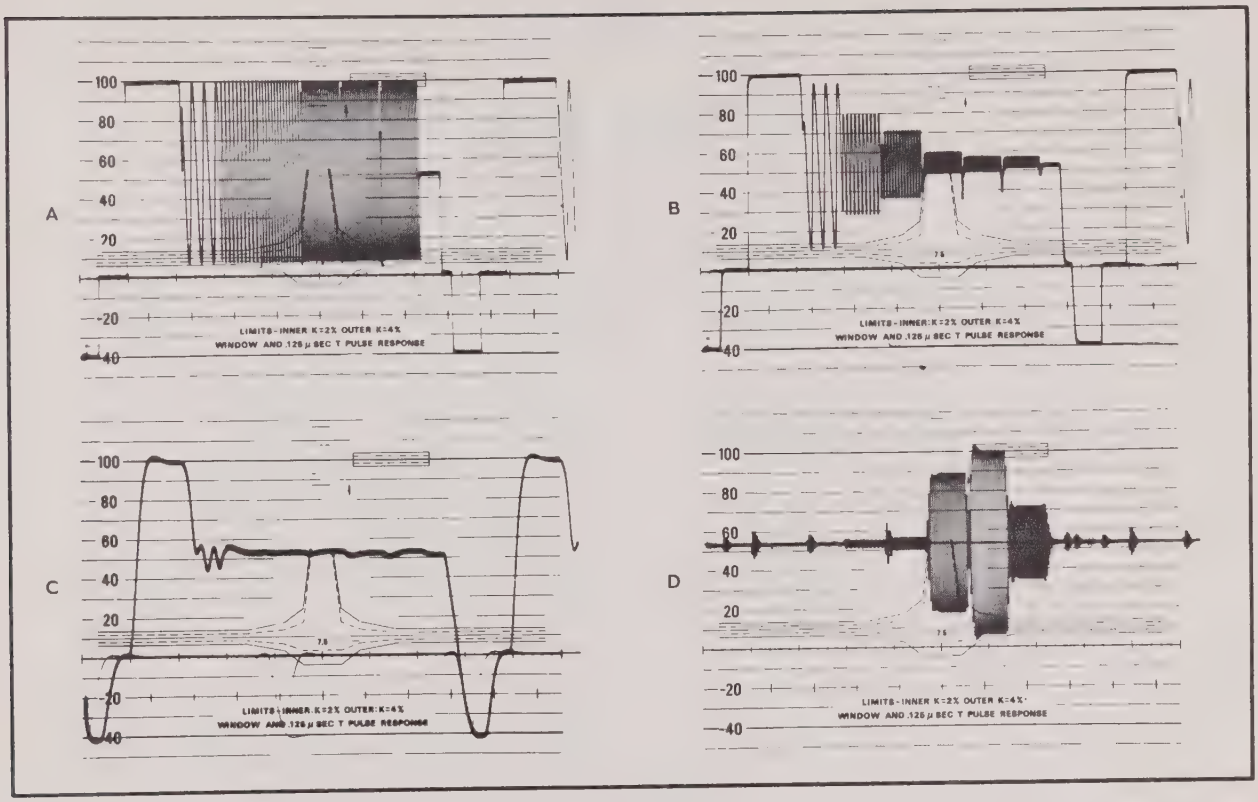

Fig. 5-4. Waveforms showing the display which will result when 1-volt of multi-burst signal is connected to the Type 529 and the RESPONSE switch is set to (a) FLAT, (b) IEEE, (c) LOW PASS, (d) HIGH PASS.

NOTES

SECTION 6

CALIBRATION

Introduction

The Type 529 Waveform Monitor is a stable instrument which will provide many hours of trouble-free operation. However, to insure measurement accuracy, it is suggested that you recalibrate the instrument after each 500 hours of operation, or every six months if used intermittently. It will also be necessary to recalibrate certain sections of the instrument when tubes, transistors or other components that affect the calibration accuracy of the instrument are replaced.

This calibration procedure can be used either for complete calibration of the Type 529 to return it to original performance, or as an operational check of instrument performance. Completion of every step in this procedure returns the Type 529 to original factory performance standards. If it is desired to merely touch up the calibration, perform only those steps entitled Adjust . . . ◑.

NOTE

The Adjust . . . steps provide a check of instrument performance before the adjustment is made. To prevent recalibration of other circuits when performing a partial calibration, readjust only if the listed tolerance is not met.

General Information

Any needed maintenance should be performed before proceeding with calibration. Troubles which become apparent during calibration should be corrected using the techniques given in the Maintenance section of this Instruction Manual.

The procedure is arranged in a sequence which allows this instrument to be calibrated with the least interaction of adjustments and reconnection of equipment. If desired, the steps may be performed out of sequence or a step may be done individually. However, some adjustments affect the calibration of other circuits within the instrument. In this case, it will be necessary to check the operation of other parts of the instrument. When a step interacts with others, the steps which need to be checked will be noted.

The location of test points and adjustments is shown in each step. Waveforms which are helpful in determining the correct adjustment or operation are also shown.

EQUIPMENT REQUIRED (see Fig. 6-1

General

The following equipment, or its equivalent, is required for complete calibration of the Type 529. Specifications given are the minimum necessary for accurate calibration of this instrument. All test equipment is assumed to be correctly calibrated and operating within the original specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

Special Test Equipment

For the quickest and most accurate calibration, special calibration fixtures are used where necessary. All calibration fixtures listed under Equipment Required can be obtained from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. DC voltmeter. Minimum sensitivity, 20,000 ohms/volt; accuracy, checked to within 1% at 25 and 100 volts, and checked to within 3% at 5300 volts. For example, Triplett Model 630 NA.

2. Constant amplitude sine-wave generator. Frequency 50 kHz and 350 kHz to above 10 MHz; output amplitude, 200 mV to 1 volt adjustable; amplitude accuracy, ±3% at 50 kHz and 350 kHz to above 10 MHz. Tektronix 191 or equivalent.

3. Test oscilloscope. Bandpass, DC to 1 MHz; minimum deflection factor. 0.005 volts/division. Tektronix Type 545B Oscilloscope with Type B Plug-in Unit, and Tektronix P6006 and P6028 Probes, or equivalent.

4. Precision DC voltmeter. Accuracy, within ±0.25 meter resolution, 50 μV range, 0.02 to 30 volts. For example, Fluke Model 825A meter.

5 Time-Mark generator. Marker outputs of 1 μs, 5 μs, 10 μs, 0 1 ms and 0.1 μs; accuracy, 0.001%. Tektronix Type 184 or equivalent.

6.[1] Variable autotransformer. Must be capable of supplying at least 80 watts to the Type 529 over a voltage range of 96 to 137 volts (192 to 274 volts for 230-volt nominal line). If autotransformer does not have an AC voltmeter to indicate output voltage, monitor output with an AC voltmeter (RMS) with range of at least 137 (or 274) volts. For example, General Radio W10MT3W Metered Variac Autotransformer.

7. Composite video signal source. Calibrated signal amplitude of 1 volt, variable from 200 mV to 1 volt. For example, Conrac model AV 12E receiver.

8. Square-wave generator. Frequency of 120 hertz; output amplitude variable from 4 to 12 volts. Tektronix Type 106, or equivalent.

9. Three Terminations. Impedance 75 ohms; accuracy, ±3%; connector, UHF. Tektronix Part No. 011-0023-00.

10. Two cables. Impedance 75 ohms; type RG 11/U; length, 42 inches; connectors, BNC. Tektronix Part No. 012-0074-00.

11. Two adapters. Connectors, BNC jack to UHF plug. Tektronix Part No. 103-0015-00.

12. Adapter. Connectors, BNC female to female. Tektronix Part No. 103-0028-00

[1]**Used only to check power-supply ripple in step 2. May be deleted if this check is not made.**

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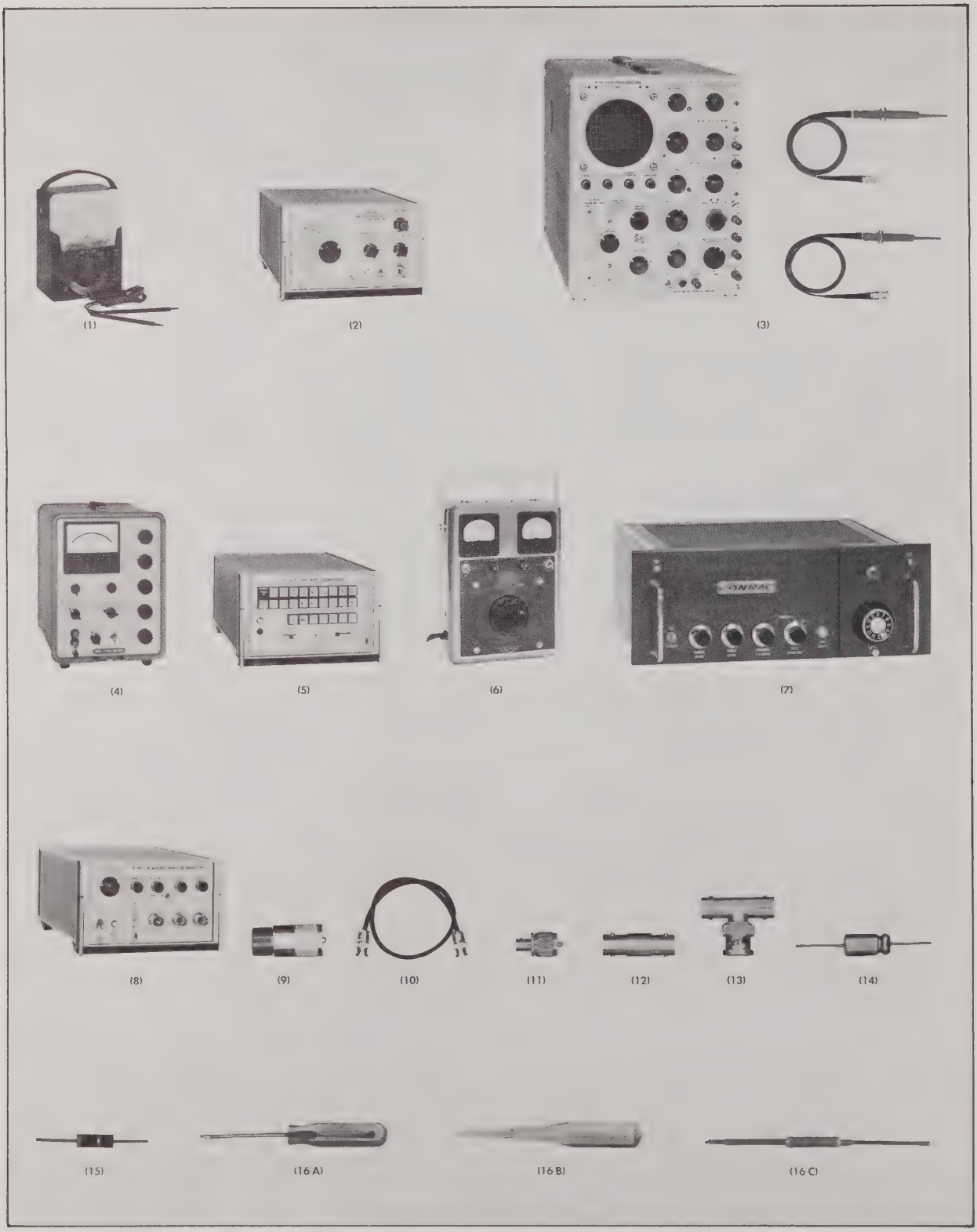

Fig. 6-1. Recommended calibration equipment.

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13. Adapter. Connectors, BNC T with two female and one male. Tektronix Part No. 103-0030-00.

14. One capacitor. 2 μF at 150 WVDC. Tektronix Part No. 290-0121-00.

15. One resistor, 27 kΩ, ¼ watt. Tektronix Part No. 315-0273-00.

16. Adjustment tools (see Fig. 6-1).

a. Screwdriver, shank about 3 inches long by 3/32-inch wide tip. Tektronix Part No. 003-0192-00.

b. Insulated low-capacitance screwdriver, Jaco No. 125, 1½-inch long shank by ⅛-inch wide metal tip Tektronix Part No. 003-0000-00.

c. Hexagonal wrench 5 inches long, for 0.100-inch inside diameter powder-iron hex slug. Tektronix Part No. 003-0301-00.

CALIBRATION RECORD AND INDEX

This abridged calibration procedure is provided to aid in checking the operation of the Type 529. It may be used as a calibration record. Since the step numbers and titles used here correspond to those used in the complete calibration procedure, the following short-form list may serve as an index. Characteristics are those listed in the Calibration section of this Instruction Manual.

Type 529, Serial No. _____

Calibration Date _____

General

In the following calibration procedure, the required test equipment is shown for each major setup change. Complete control settings are listed below the picture. If only a partial calibration is performed, start with the nearest setup preceding the desired portion.

NOTE

When performing a complete recalibration, best performance will be provided if each adjustment is made to the exact setting, even if the Check is within the allowable tolerance.

The following procedure uses the equipment listed under Equipment Required. If substitute equipment is used, control settings or setup must be altered to meet the requirements of the equipment used.

☐ 1. Adjust VOLTS/CAL AMPL (R620). Page 6-5.
—25 volts; correct calibrator amplitude.

☐ 2. Check Low-Voltage Power-Supply Regulation and Ripple. Page 6-7.
—25 volts, ±3%; +100 volts, ±5%;
—25 volts ripple, ≤10 mV maximum; +100 volts ripple, ≤100 mV maximum.

☐ 3. Adjust HIGH VOLTAGE (R835). Page 6-8.
—5300 volts.

☐ 4. Check High Voltage Regulation. Page 6-8.
—5300 volts, ±5%.

☐ 5. Adjust ASTIG (R864). Page 6-9.
Well-defined display.

☐ 6. Adjust CRT BEAM ROTATOR (R655). Page 6-9.
Trace parallel to horizontal graticule lines.

☐ 7. Adjust UNBLANKING PLATE BIAS (R855). Page 6-9.
Adjust for uniform intensity along horizontal axis.

☐ 8. Adjust DC BAL (R115). Page 6-10.
No vertical trace movement as VOLTS FULL SCALE switch is rotated.

☐ 9. Adjust VAR DC BAL (R130). Page 6-10.
No vertical trace movement as VARIABLE (VOLTS FULL SCALE) control is rotated.

☐ 10. Adjust VERT GAIN (R169). Page 6-11.
1 volt peak to peak of external calibrator signal must produce 140 IEEE units of deflection. VOLTS FULL SCALE switch at 1.0.

☐ 11. Adjust Vertical 0.2 VOLTS FULL SCALE GAIN (R119). Page 6-11.
Calibrator signal must produce 140 IEEE units of deflection VOLTS FULL SSCALE switch at 0.2.

☐ 12. Check Vertical 0.5 VOLTS FULL SCALE Gain Accuracy. Page 6-11.
Calibrator signal must produce 140 IEEE units of deflection ±4%. VOLTS FULL SCALE switch at 0.5.

☐ 13. Adjust TRIG MULTI BIAS (R325). Page 6-12.
Set for stable display.

☐ 14. Check External Sync. Page 6-13.
Stable display with 20 IEEE units of display. VOLTS FULL SCALE switch at 0.2.

☐ 15. Check DC RESTORER Switch. Page 6-13.
Less than ±4 IEEE units of shift as VOLTS FULL SCALE switch is rotated through its settings.

☐ 16. Adjust HORIZ GAIN (R568). Page 6-14.
10.2 cm sweep length.

☐ 17. Adjust Miller Timing Capacitor (C481). Page 6-15.
80 μs of sweep in 10 cm.

☐ 18. Adjust ×25 Horizontal Sweep Magnifier Capacitor (C521). Page 6-15.
Thirty-two 5 and 10 μs time markers per 10 cm.

☐ 19. Check ×5 Magnified Sweep timing. Page 6-16.
16 one μs time markers per 10 cm, ±3%.

☐ 20. Adjust FIELD 1 SYNC (R360). Page 6-17.
Ramp starts after sixth equalizing pulse.

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☐ 21. Check FIELD Switch. Page 6-18.

ONE field—31.75 μs between last horizontal sync pulse and first equalizing pulse.

TWO field—63.5 μs between last horizontal sync pulse and first equalizing pulse.

☐ 22. Adjust SWP/MAG REGIS (R575). Page 6-19.

Display in center of graticule does not shift horizontally as MAG switch is changed from ×25 to ×1.

☐ 23. Check Line Selector Brightening Pulse Amplitude. Page 6-20.

At least 100 mV high.

☐ 24. Adjust VIT LINE SEL RANGE (R458); SN998-up. Page 6-21.

Set for a DC voltmeter reading which is halfway between the two readings obtained when the brightening pulse just started to jump between the 21st and 22nd lines and the 20th and 21st lines.

☐ 25. Check Line Selector Operation, SN 998-up. Page 6-21.

With LINE SELECTOR switch set to VARIABLE and VARIABLE fully counterclockwise, brightening pulse must start on or before the 15th line.

With VARIABLE (LINE SELECTOR) fully clockwise, brightening pulse must start after the first 25% of the second field. When LINE SELECTOR switch is set to a numbered position, the brightening pulse must start at the start of that numbered line.

☐ 26. Check Vertical Amplifier High-Frequency Response. Page 6-22.

Refer to Table 6-2.

☐ 27. Adjust Vertical-Amplifier 1.0 Flat-Frequency Response (C269, L162 and L262). Page 6-22.

Flat-frequency response from 500 kHz to 5 MHz, +0, 1% and flat response from 500 kHz to 8 MHz, +0, 3%.

☐ 28. Adjust Vertical Amplifier 0.2 Flat-Frequency Response (C118B). Page 6-24.

Flat frequency response from 500 kHz to 5 MHz, +0, 1%.

☐ 29. Adjust Vertical Amplifier 0.5 Flat-Frequency Response (C118C). Page 6-24.

Flat-frequency response from 500 kHz to 5 MHz, +0, 1%.

☐ 30. Adjust Common Mode Rejection. Page 6-24.

Minimum display amplitude of common 2 MHz signal.

☐ 31. Adjust Vertical Amplifier Chroma Frequency Response (T135). Page 6-25.

Set bottom transformer slug for 100 IEEE units of deflection at 3.58 MHz.

Set top transformer slug for 70 to 85 IEEE units of deflection at 3.18 MHz.

Check for 70 to 85 IEEE units of deflection at 3.98 MHz.

☐ 32. Check J501 Staircase Input. Page 6-26.

Four displays in 10 cm.

☐ 33. Adjust Bar Response of Pulse and Bar VIT Signal (C167). Page 6-27

Adjust for optimum flat top.

☐ 34. (Optional Method) Check Vertical Amplifier High-Frequency Response. Page 6-29.

Preliminary Procedure

1. Remove from any enclosure, so as to provide access to all internal adjustments and test points, including rear-panel connectors.

2. Check that a 160-IEEE unit 7-cm composite graticule (331-0161-00) is installed and that tthe VIDEO OUTPUT connector is terminated into 75Ω.

3. Connect the autotransformer (if used) to a suitable power source.

4. Connect the Type 529 power cord to the autotransformer output (or directly to the power source).

5. Set the autotransformer to 115 (or 230) volts.

6. Set the Type 529 POWER and SCALE ILLUM switch to on. Allow at least 20 minutes warm up, for checking the instrument to the given accuracies.

NOTES

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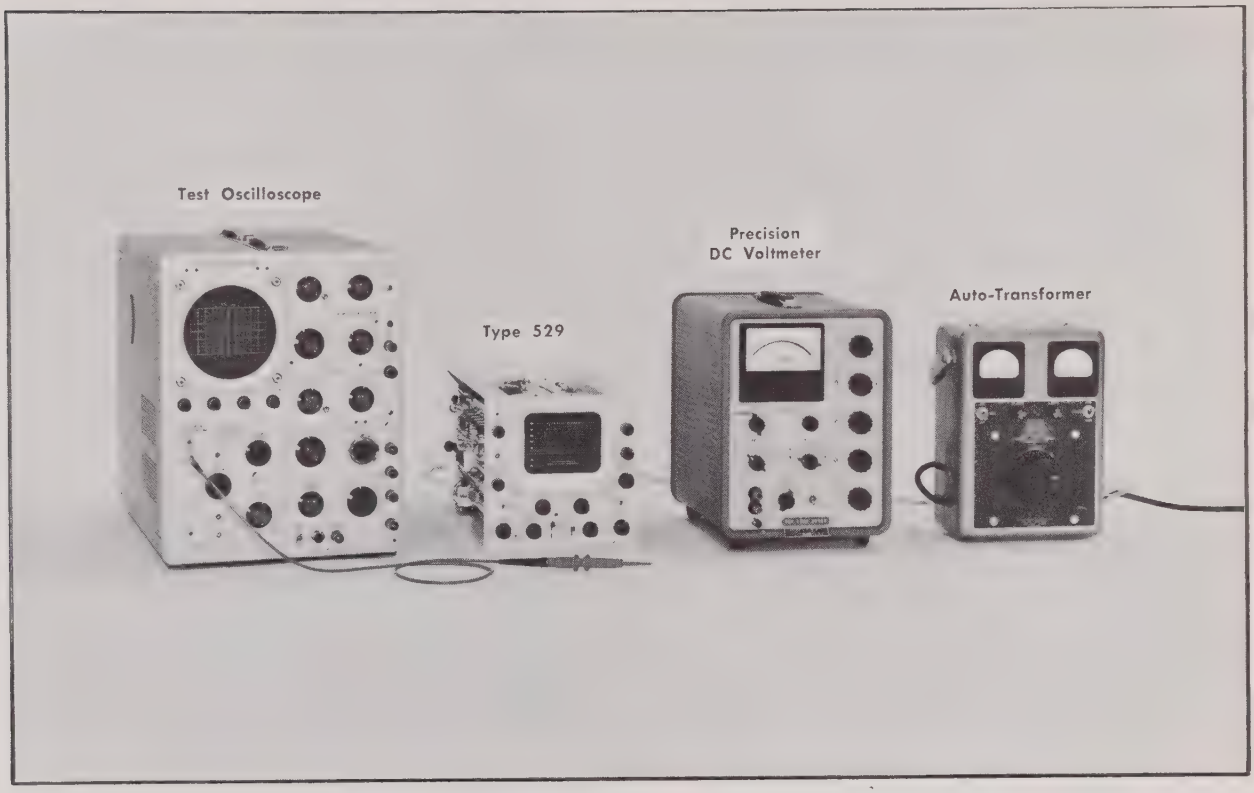

Fig. 6-2. Test equipment required for steps 1 and 2.

POWER and SCALE ILLUM	2/3 clockwise
FOCUS	Midrange
INTENSITY	Fully counterclockwise
GAIN	Midrange

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	OFF
INPUT	CAL
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	FULL SCALE
POSITION	Midrange

HORIZ Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	2 FIELD
FIELD	TWO
VARIABLE LINE SELECTOR	Midrange
LINE SELECTOR Switch	VARIABLE

PROCEDURE

1. Adjust —25 VOLTS/CAL AMPL (R620)

NOTE

Do not reset the —25 VOLTS/CAL AMPL (R620) unless the power-supply voltages are actually out of tolerance or you are planning to perform a complete calibration of the instrument.

a. Test equipment setup is shown in Fig. 6-2.

b. Connect a precision DC voltmeter between the —25 V supply and ground. See Fig. 6-3A.

c. Check for a meter reading of —25 volts.

d. Adjust the —25 VOLTS/CAL AMPL control (R620; see Fig. 6-3B) for a meter reading of —25 volts.

e. Disconnect the voltmeter.

f. Turn off the Type RM529 power.

g. Remove Q804 and Q874.

h. Turn on the Type 529 power.

i. Connect the precision DC voltmeter between the junction of R885-R881 and ground; see Fig. 6-3C.

j. Note the exact meter reading.

k. Turn off the Type 529 power.

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l. Reinstall Q874 and connect a 1/4 watt, 27 kΩ resistor between the base of Q874 and ground.

m. Turn the Type 529 power on.

n. Note the exact meter reading; it will be approximately —0.976 volts.

o. Check that 1.0 volt minus the meter reading noted in part j of this step equals the meter reading noted in part n of this step.

p. Adjust the —25 VOLTS/CAL AMPL control (R620; see Fig. 6-3B) until the meter reading equals 1.0 volt minus the meter reading noted in part j of this step.

NOTE

Without the use of a high input impedance precision DC voltmeter such as item number four in the Equipment Required list, adjustment accuracy within 1% cannot be obtained.

q. Turn off the Type 529 power.

r. Remove the 27 kΩ resistor from Q874 and re-install Q804.

s. Disconnect the voltmeter.

t. Turn the Type 529 power on.

u. Interaction—May affect operation of all circuits.

1A. ADJUST —25 VOLTS/CAL AMPL (R620)

Alternate method of adjusting the —25 VOLTS/CAL AMPL (R620) using a good DC voltmeter.

NOTE

This method of adjustment may lack some of the accuracy of the method outlined in Step 1. Therefore, it is recommended that a precision voltmeter be used to make this adjustment. Factors affecting the accuracy of this method include the calibration of the DC voltmeter and the calculation of the correction factor for the meter loading.

a. Test equipment setup is as shown in Fig. 6-2.

b. Connect a DC voltmeter between the —25 volt supply and ground. See Fig. 6-3A.

c. Check for a meter reading of —25 volts.

d. Adjust the —25 VOLTS/CAL AMPL control (R620; see Fig. 6-3B) for a meter reading of —25 volts.

e. Disconnect the voltmeter.

f. Turn off the Type 529 power.

g. Remove Q804 and connect a 27 kΩ, 1/4 W, 5% resistor from the base of Q874 to ground.

h. Turn the Type 529 power on.

i. Connect the DC voltmeter between the junction of R885-R881 and ground; see Fig. 6-3C.

j. Note the exact meter reading; it will be approximately —.976 volts.

k. Adjust the —25 VOLTS/CAL AMPL control (R620) for a meter reading of —.97 volts minus the correction factor for meter loading.

Example: a 20,000 ohm/volt voltmeter on the 1.5 volt full scale range has an input resistance of 30,000 ohms and will cause a 3% error in this circuit. ($\frac{\text{Circuit resistance}}{\text{Meter resistance}}$ = % Loading Error.)

Therefore, the —25 VOLT/CAL AMPL control should be adjusted for a reading of —.94 volts (.97 minus .03 = .94).

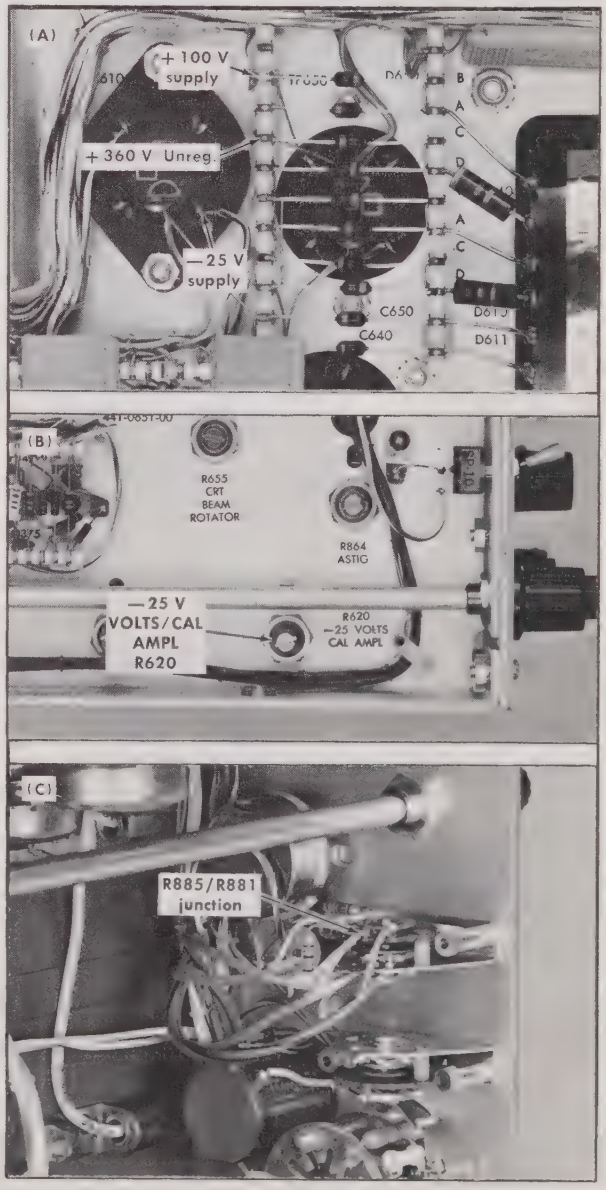

Fig. 6-3. (A) Location of low-voltage power supply test points. (B) Location of —25 VOLTS/CAL AMPL adjustments. (C) Location of R885-R881 junction.

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2. Check Low-Voltage Power-Supply Regulation and Ripple

a. Test equiment setup is shown in Fig. 6-2.

b. Set the CAL switch to .714 F.S. to display 100 IEEE units of vertical deflection.

c. Vary the autotransformer so the line voltage is set 10% above design center (for 115 V, +10% is 126.5 V) and hold for 1 minute at this voltage extreme. Check voltage regulation and ripple according to the information given in Table 6-1 and Fig. 6-3A.

d. Vary the autotransformer so the line voltage is set 10% below design center (for 115 V, —10% is 103.5 V) and hold for 1 minute at this voltage extreme. Check voltage regulation and ripple as given in Table 6-1 and Fig. 6-3A.

TABLE 6-1

Typical Ripple Amplitudes

Supply	Voltage Deviation[2]	Ripple Amplitude
—25 V	±3% or 0.75 V	≤10 mV
+100 V	±5% or 5 V	≤100 mV

e. Set the autotransformer for design center line voltage.

f. Disconnect the DC voltmeter and 1× probe.

[2]Deviation from the voltage reading obtained at design center; for example, if —25 V supply indicates a reading of —25.7 V on the DC voltmeter at design center, deviation should be within the range from —24.95 V to —26.45 V.

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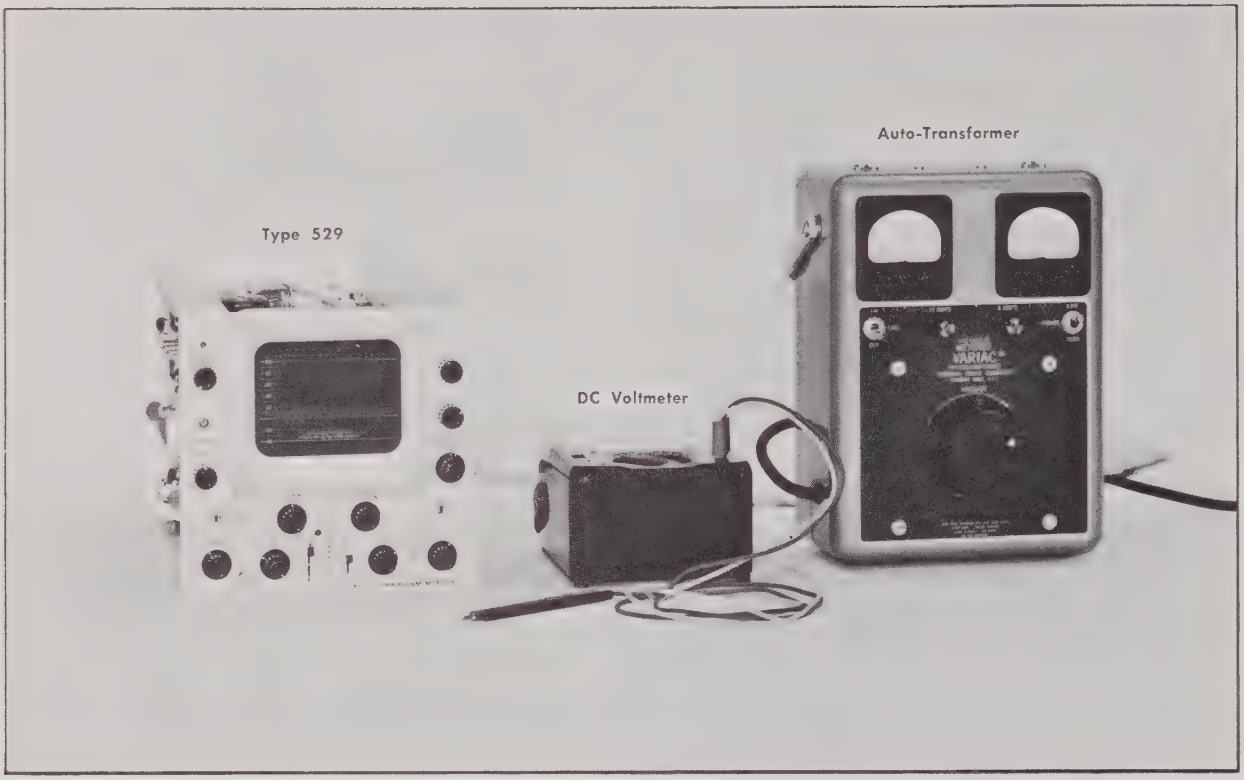

Fig. 6-4. Test equipment required for steps 3 and 4.

POWER and SCALE ILLUM	⅔ clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	OFF
INPUT	CAL
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F.S.
POSITION	Midrange

HORIZ Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	2 FIELD
FIELD	TWO
VARIABLE LINE SELECTOR	Midrange
LINE SELECTOR Switch	VARIABLE

3. Adjust HIGH VOLTAGE (R835)

a. Test equipment required is shown in Fig. 6-4.

b. Connect the DC voltmeter between the center arm of the INTENSITY control (see Fig. 6-5) and ground.

c. Rotate the GAIN control from one extreme to the other.

d. Check that the meter reading varies.

e. Set the GAIN control to its midrange position.

f. Check for a meter reading of —5300 V.

g. Adjust the HIGH VOLTAGE control (R835; see Fig. 6-5) to obtain a meter reading of —5300 V.

h. Interaction—May affect operation of all circuits.

4. Check HIGH VOLTAGE Regulation

a. Test equipment required is shown in Fig. 6-4.

b. Vary the autotransformer so the line voltage is set 10% above design center and hold for 1 minute at this

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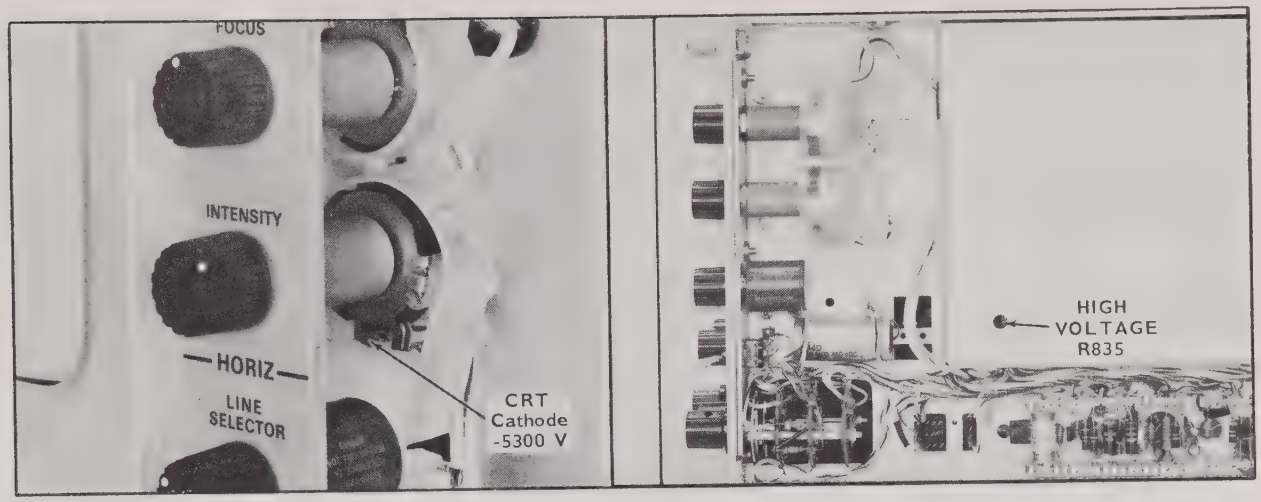

Fig. 6-5. Location of high-voltage test point and of HIGH VOLTAGE adjustment.

extreme. Check that the high voltage remains essentially constant (within ±5% or 265 volts of the —5300-volt reading.

c. Vary the autotransformer so the line voltage is set 10% below design center and hold for 1 minute at this extreme. Check that the high voltage remains essentially constant (within ±5% or 265 volts of the —5300-volt reading).

d. Set the autotransformer for design-center line voltage.

e. Disconnect the DC voltmeter.

5. Adjust ASTIG (R864)

a. Set the DISPLAY switch to 2 LINE.

b. Check for well-defined display with normal brightness.

c. Adjust the FOCUS and ASTIG controls (R864; see Fig. 6-6) to obtain a well-defined display using normal brightness.

6. Adjust CRT BEAM ROTATOR (R655)

a. Set the DISPLAY switch to 2 FIELD.

b. Check that flat bottom of calibrator square waves coincides with graticule line.

c. Adjust the CRT BEAM ROTATOR control (R655; see Fig. 6-7) so the flat bottom of the calibrator square waves coincides with the graticule line.

7. Adjust UNBLANKING PLATE BIAS (R855)

a. Set the INPUT switch to A (no signal applied to VIDEO INPUTS A connector).

b. Adjust the INTENSITY control so the CRT trace is barely visible.

c. Check for uniform intensity along the horizontal axis.

d. Adjust the UNBLANKING PLATE BIAS (R855; see Fig. 6-8) for uniform intensity along the horizontal axis.

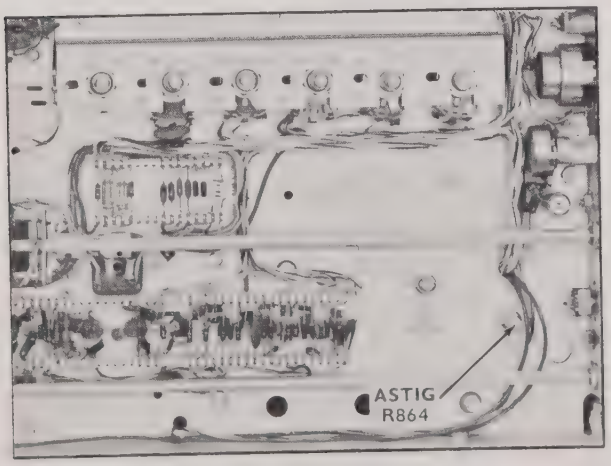

Fig. 6-6. Location of ASTIG adjustment.

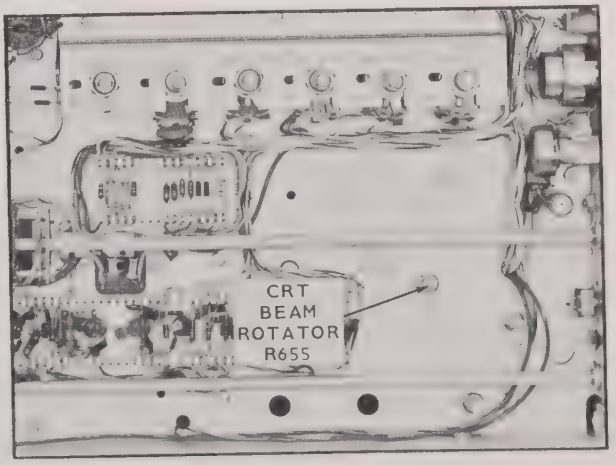

Fig. 6-7. Location of CRT BEAM ROTATOR adjustment.

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8. Adjust DC BAL (R115)

a. Adjust the INTENSITY control for normal display brightness.

b. Check for no vertical trace movement as (VERTICAL) VOLTS FULL SCALE switch is changed from 1.0 to 0.2 and 0.5 positions.

c. Adjust the DC BAL control (R115; see Fig. 6-9) for no vertical movement of the trace as (VERTICAL) VOLTS FULL SCALE switch is set to 0.2, to 0.5, and then returned to 1.0. Repeat this procedure, if necessary, to check that the adjustment is made properly.

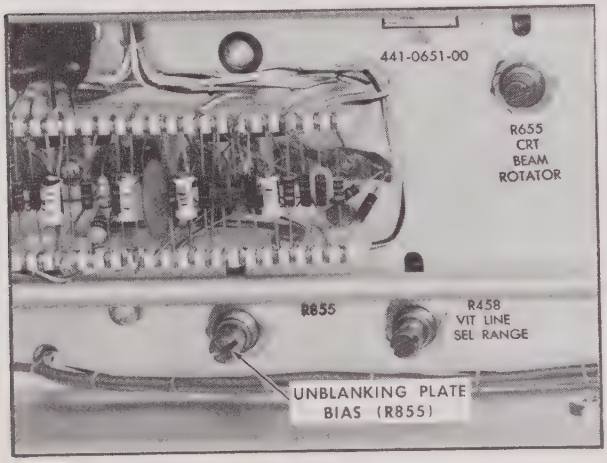

Fig. 6-8. Location of UNBLANKING PLATE BIAS adjustment.

9. Adjust VAR DC BAL (R130)

a. Check that the (VERTICAL) VOLTS FULL SCALE switch is set to 1.0.

b. Check for no vertical trace movement as the (VERTICAL) VARIABLE (VOLTS FULL SCALE) control is rotated from extreme to extreme.

c. Adjust the VAR DC BAL control (R130; see Fig. 6-10) for no vertical movement of the trace as the (VERTICAL) VARIABLE (VOLTS FULL SCALE) control is rotated from extreme to extreme.

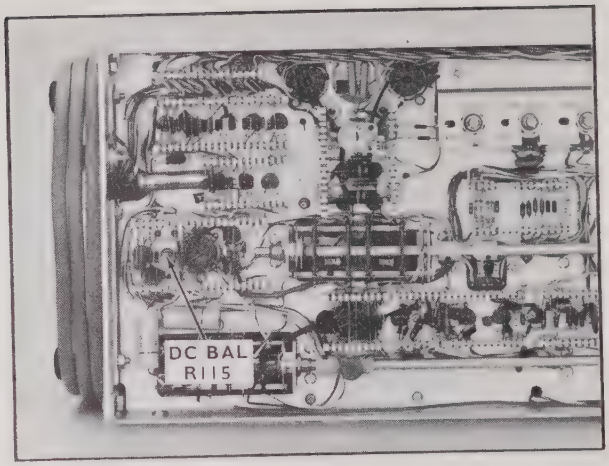

Fig. 6-9. Location of DC BAL adjustment.

d. Set the (VERTICAL) VARIABLE (VOLTS FULL SCALE) control to the CALIB position.

e. Interaction-Recheck step 8.

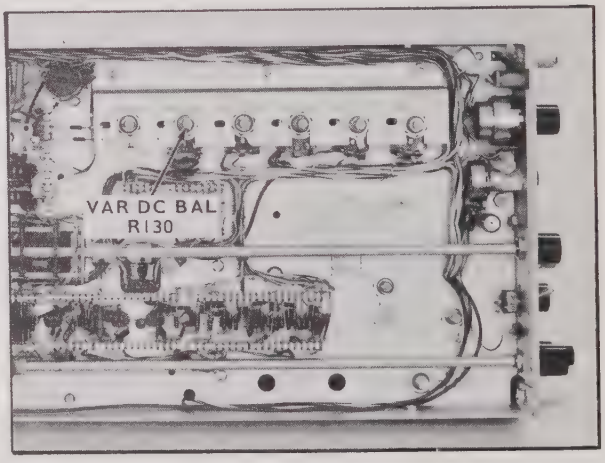

Fig. 6-10. Location of VAR DC BAL adjustment.

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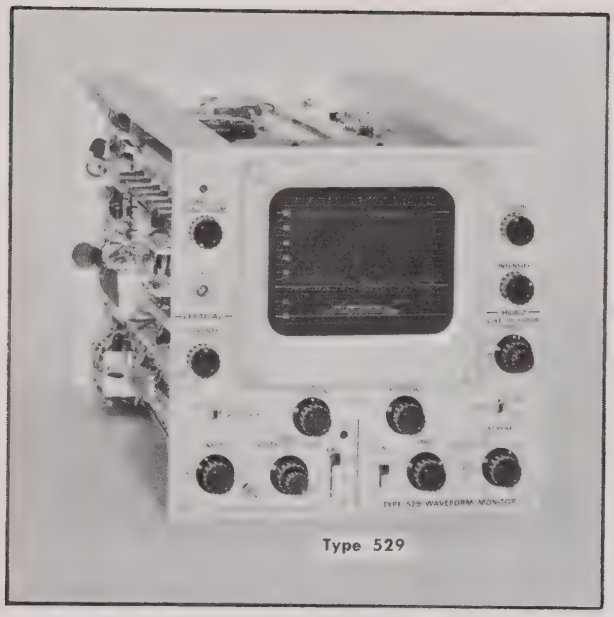

Fig. 6-11. Test setup for steps 10 through 12.

POWER and SCALE ILLUM	2/3 clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	OFF
INPUT	CAL
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	FULL SCALE
POSITION	Midrange

HORIZ Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	2 FIELD
FIELD	TWO
VARIABLE LINE SELECTOR	Midrange
LINE SELECTOR Switch	VARIABLE

10. Adjust VERT GAIN (R169)

a. Test equipment required is shown in Fig. 6-11.

b. Adjust the VERT GAIN control (R169; see Fig. 6-12) to obtain exactly 140 IEEE units of vertical deflection.

11. Adjust VERTICAL 0.2 VOLTS FULL SCALE GAIN (R119)

a. Test equipment setup is given in step 10.

b. Set the (VERTICAL) VOLTS FULL SCALE switch to 0.2.

c. Check for exactly 140 IEEE units of vertical deflection.

d. Adjust the 0.2 VOLTS FULL SCALE GAIN control (R119; see Fig. 6-13) for exactly 140 IEEE units of vertical deflection.

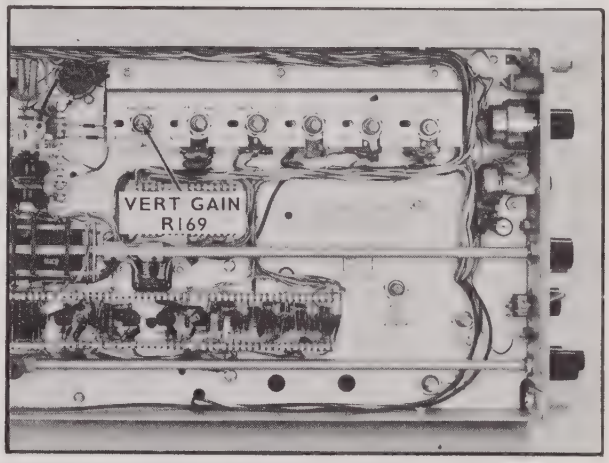

Fig. 6-12. Location of VERT GAIN adjustment.

12. Check Vertical 0.5 VOLTS FULL SCALE Gain Accuracy

a. Test equipment setup is given in steps 10 and 11.

b. Set the (VERTICAL) VOLTS FULL SCALE switch to 0.5.

c. Check that the vertical deflection of the display is 140 IEEE units within a tolerance of ±4 IEEE units.

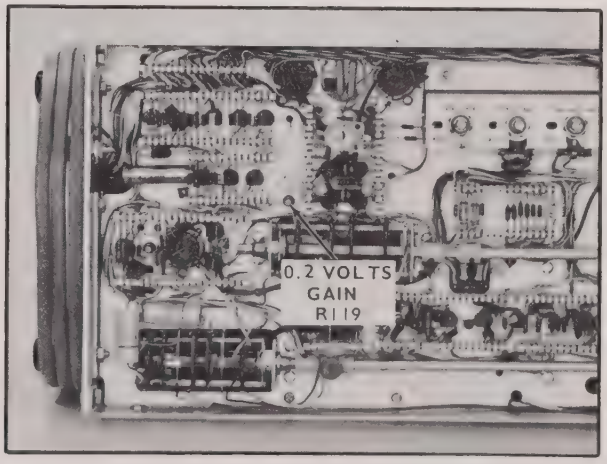

Fig. 6-13. Location of 0.2 VOLTS adjustment.

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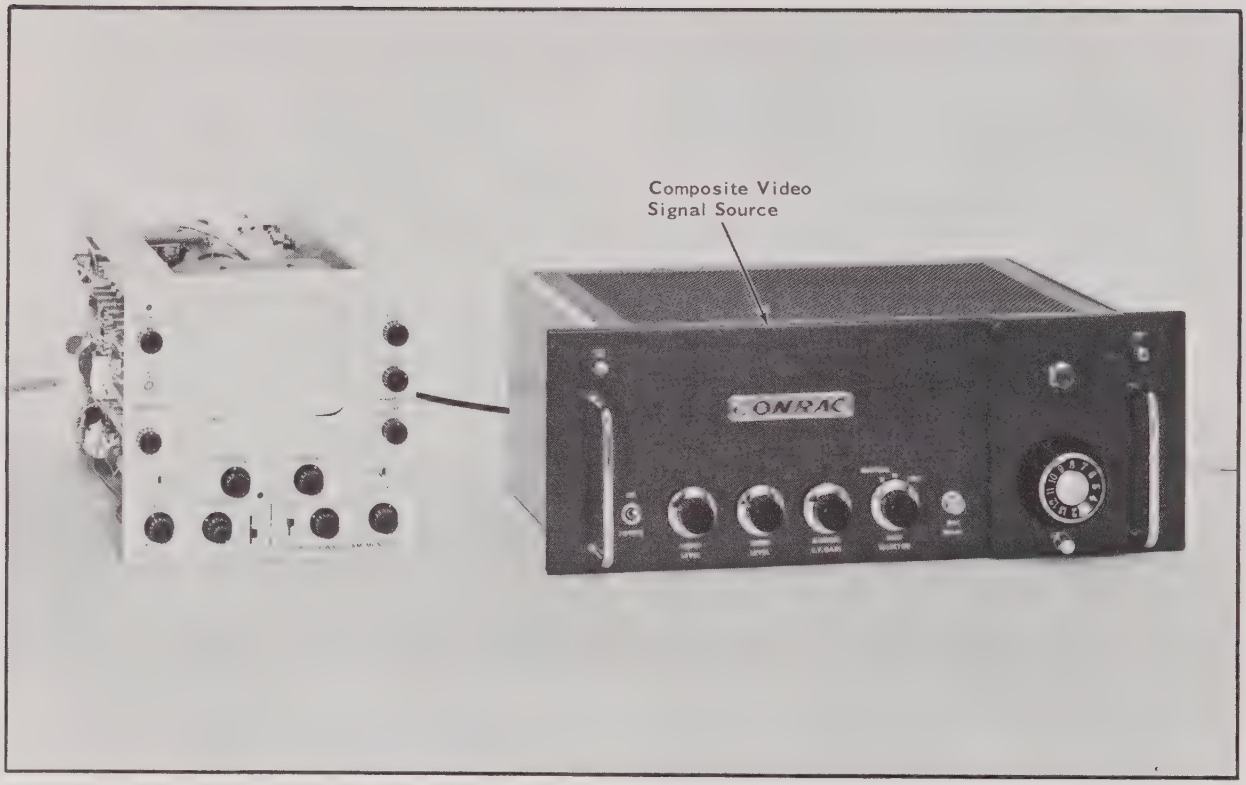

Fig. 6-14. Test equipment setup for steps 13, 14 and 15.

POWER and SCALE ILLUM	⅔ clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	OFF
INPUT	A
VOLTS FULL SCALE	.2
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	FULL SCALE
POSITION	Midrange

HORIZ Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	2 FIELD
FIELD	TWO
VARIABLE LINE SELECTOR	Midrange
LINE SELECTOR Switch	VARIABLE

13. Adjust TRIG MULTI BIAS (R325)

a. Test equipment setup is shown in Fig. 6-14.

b. Connect a composite video signal to the left EXT NEG SYNC INPUT connector.

c. Connect a coaxial cable from the right EXT NEG SYNC INPUT connector to the right VIDEO INPUTS A connector.

d. Connect a 75-ohm termination to the left VIDEO INPUTS A connector.

e. Adjust the source signal level to produce 140 IEEE units of sync amplitude.

f. Check for a stable display.

g. Adjust by first rotating the TRIG MULTI BIAS control (R325; see Fig. 6-15) fully counterclockwise. Then, rotate the control slowly clockwise until the display is synchronized: that is, a stationary display is obtained.

NOTE

If the Type 529 is used to monitor video signals containing noise, rotate the TRIG MULTI BIAS control about 20° further clockwise from the point where a stable display was first obtained. If the control is turned too far clockwise, a jittery display will be obtained. The control should always be be set within the stable display range.

h. As a check that the TRIG MULTI BIAS control is properly adjusted, set the (VERTICAL) VOLTS FULL SCALE switch

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to 1.0, adjust the source signal level for a larger sync amplitude (up to 140 IEEE units) and check that the display remains synchronized.

14. Check External Sync

a. Test equipment setup is given in step 13.

b. Set the SYNC switch to EXT.

c. Set the (VERTICAL) VOLTS FULL SCALE switch to 0.5.

d. Adjust the video source signal level so the vertical deflection is 70 IEEE units of sync amplitude.

e. Check that a stable display is obtained.

15. Check DC RESTORER Switch

a. Test equipment setup is given in step 13.

b. Set the front-panel controls to these settings:

VOLTS FULL SCALE	1.0
DC RESTORER	ON
INPUT	CAL
CALIBRATOR	.714 F.S.
SYNC	INT

c. Using the (VERTICAL) POSITION control, position the bottom of the calibrator waveform so it coincides with the 0 IEEE graticule line.

d. Set the INPUT switch to A.

e. Check that the back porch level of the video signal coincides with the 0 IEEE graticule line.

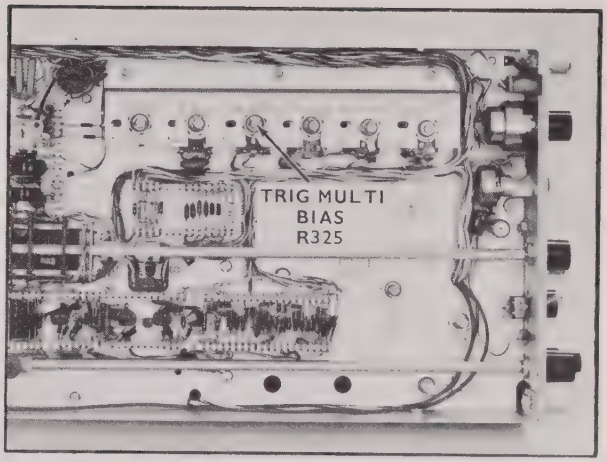

Fig. 6-15. Location of TRIG MULTI BIAS adjustment.

f. Set the INPUT switch to CAL.

g. Set the (VERTICAL) VOLTS FULL SCALE switch from 1.0 to 0.2, 0.5. Check for ±4 IEEE units or less vertical movement of the calibrator waveform from 0 IEEE.

h. Set the (VERTICAL) VOLTS FULL SCALE switch to 1.0 and DC RESTORER switch to off.

i. Disconnect the video signal from the lower EXT NEG SYNC INPUT connector.

j. Disconnect the jumper coaxial cable.

NOTES

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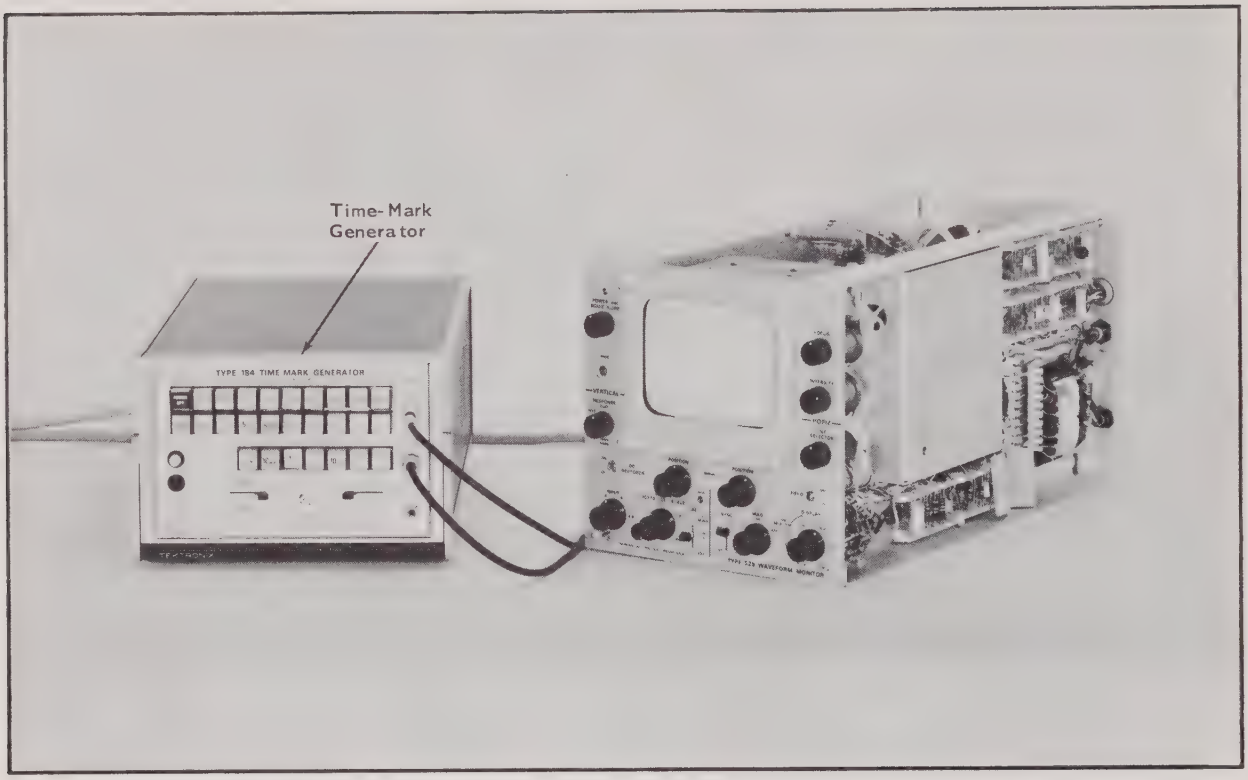

Fig. 6-16. Test equipment setup for steps 16 through 19.

POWER and SCALE ILLUM	⅔ clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	OFF
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F.S.
POSITION	Midrange

HORIZ Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	2 FIELD
FIELD	TWO
VARIABLE LINE SELECTOR	Midrange
LINE SELECTOR Switch	VARIABLE

16. Adjust HORIZ GAIN (R568)

a. Test equipment setup is shown in Fig. 6-16.

b. Connect 5-μs and 10-μs time markers from the time mark generator to the right VIDEO INPUTS A connector.

c. Check that the 75-ohm termination is still connected to the left VIDEO INPUTS A connector.

d. Apply 100-μs trigger pulses from the time-mark generator to the upper EXT NEG SYNC INPUT connector.

e. Set the SYNC switch to EXT and the DISPLAY switch to .125H/CM.

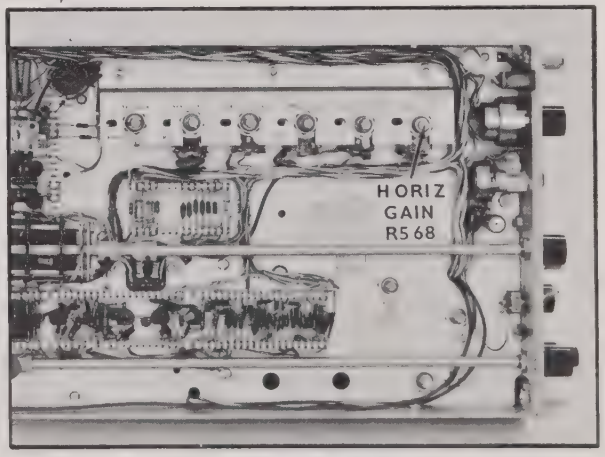

Fig. 6-17. Location of HORIZ GAIN adjustment.

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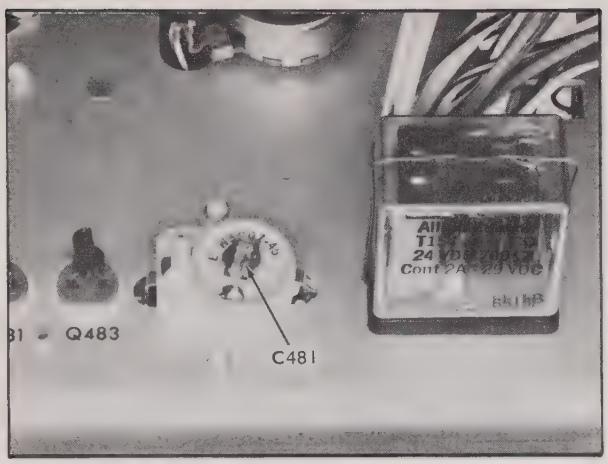

Fig. 6-18. Location of C481 adjustment.

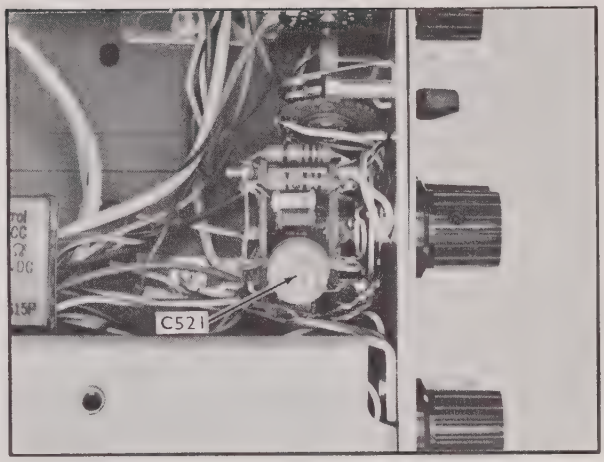

Fig. 6-20. Location of C521 adjustment.

NOTE

Use the (VERTICAL) VOLTS FULL SCALE and VARIABLE (VOLTS FULL SCALE) controls to adjust the vertical amplitude of the display in steps 16 through 19.

f. Check for a sweep length of 10.2 cm.

g. Adjust the HORIZ GAIN control (R568; see Fig. 6-17) for a sweep length of 10.2 cm.

h. Interaction-Check step 17.

17. Adjust Miller Timing Capacitor (C481) ◐

a. Test equipment setup is given in step 16.

b. Check for 80 μs of sweep in 10 cm.

c. Adjust the MILLER timing capacitor (C481; see Fig. 6-18) for 80 μs per 10 cm (see Fig. 6-19).

d. Interaction-Check step 16.

18. Adjust ×25 Horizontal Sweep Magnifier Capacitor (C521) ◐

a. Test equipment setup is given in step 16.

NOTE

To minimize horizontal jitter, set the time-mark generator trigger rate for 1ms trigger output. After completing this step, set trigger rate to 0.1 ms.

b. Set the time-mark generator for a .1 μs time marker.

c. Set the (HORIZ) MAG switch to ×25.

d. Check for 32 time markers per 10 cm.

e. Adjust the horizontal sweep magnifier capacitor (C521; see Fig. 6-20, primirily for sweep timing and secondarily

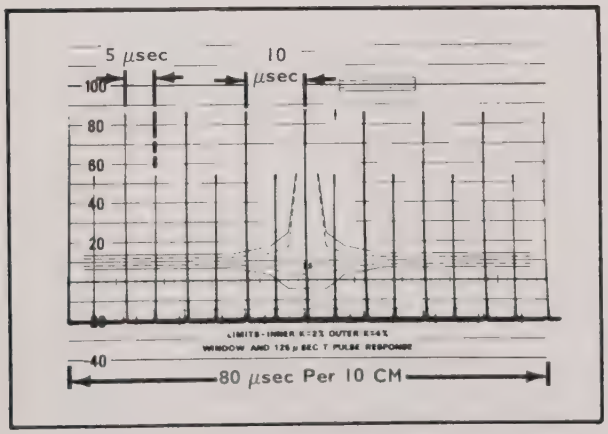

Fig. 6-19. Adjusting C481 for correct ×1 sweep timing.

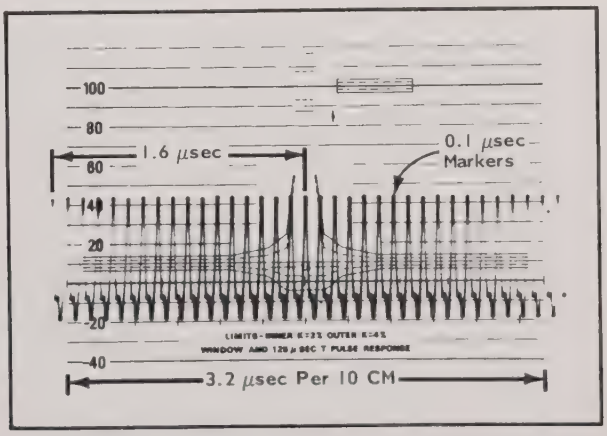

Fig. 6-21. Adjusting C521 for optimum ×25 sweep linearity.

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for linearity. For correct timing, 32 time markers per 10 cm should be displayed (see Fig. 6-22). For checking linearity display should show 8 time markers for any 2.5-cm portion of the display.

19. Check ×5 Magnified Sweep Timing

a. Test equipment setup is given in step 16.

b. Set the time-mark generator output for 1-μs time-marker output and check that the trigger rate is 0.1 ms.

c. Set the (HORIZ) MAG switch to ×5.

d. Check for 16 μs of sweep time per 10 cm (see Fig. 6-22). Sweep-timing tolerance should be within ±3 mm.

e. Disconnect the time markers and external trigger.

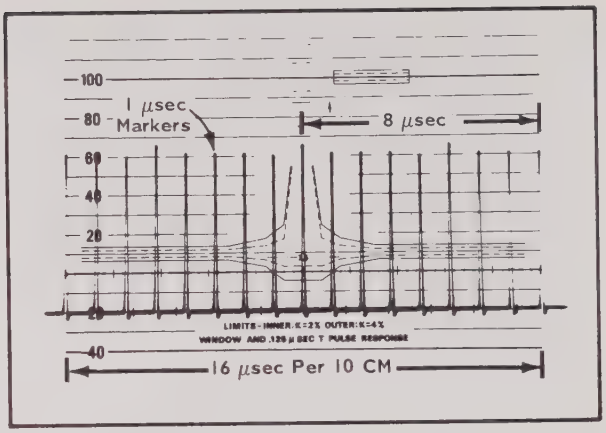

Fig. 6-22. Checking the ×5 sweep timing.

NOTES

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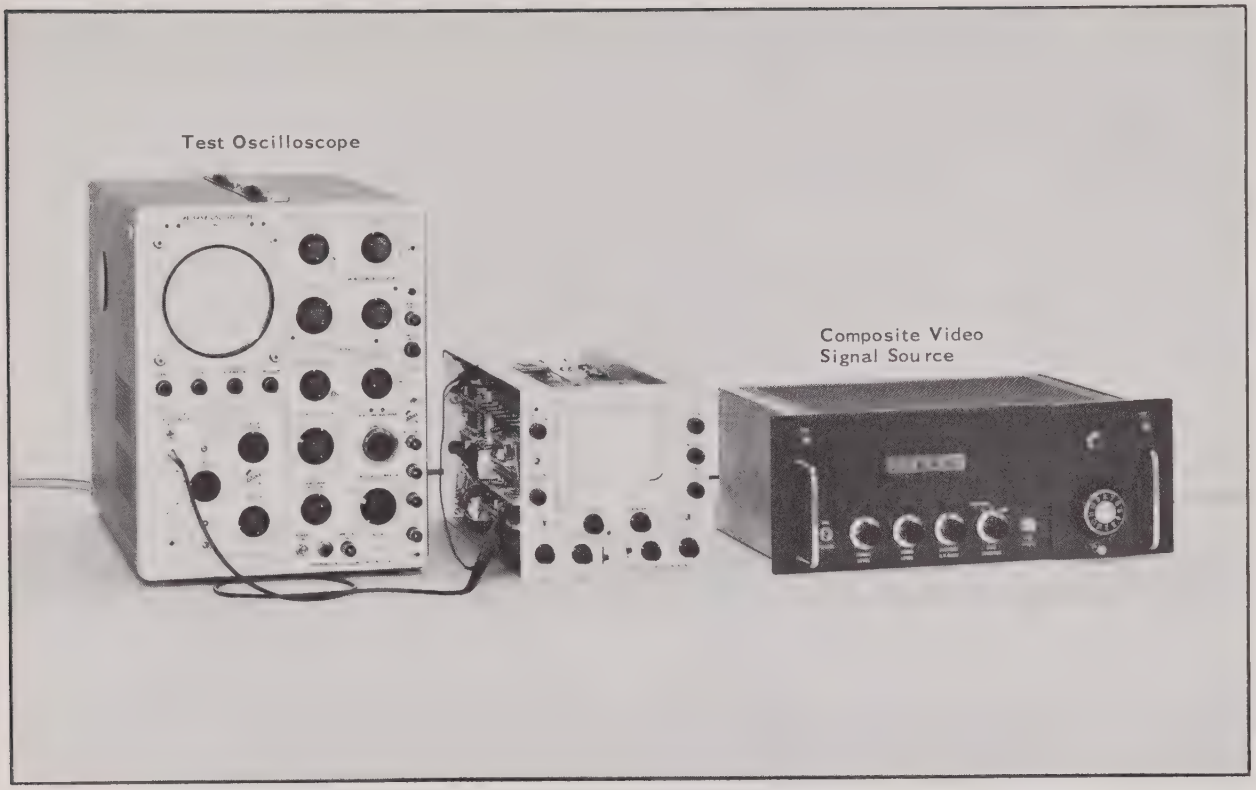

Fig. 6-23. Test equipment setup for steps 20 through 22.

POWER and SCALE ILLUM	⅔ clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	ON
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F.S.
POSITION	Midrange

HORIZ Controls

POSITION	Midrange
SYNC	INT
MAG	×25
DISPLAY	2 FIELD
FIELD	TWO
VARIABLE LINE SELECTOR	Midrange
LINE SELECTOR Switch	VARIABLE

20. Adjust FIELD 1 SYNC (R360)

a. Test equipment setup is shown in Fig. 6-23.

b. Connect 1-volt composite video signal to the right VIDEO INPUTS A connector.

c. Check that a 75-ohm termination is connected to the left VIDEO INPUTS A connector.

d. Set the test oscilloscope controls as follows:

Sweep Rate	50 μs/cm
Triggering	+Ext, AC

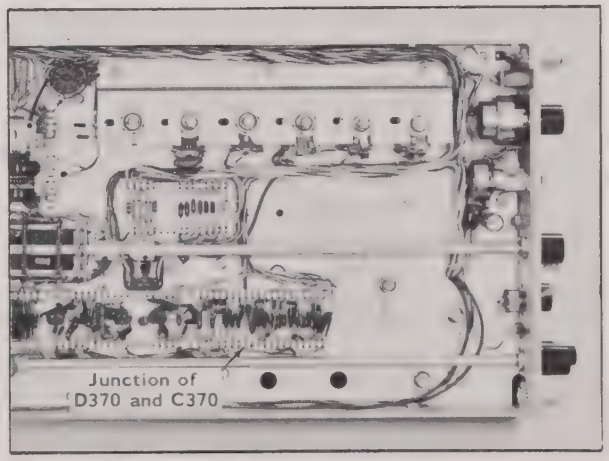

Fig. 6-24. Location of D370/C370 junction.

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Signal Input Coupling	AC
Vertical Deflection Factor (with 10× attenuator probe)	5 Volts/cm

e. Connect the 10× probe from the vertical input connector to the junction of D370 and C370 (see Fig. 6-24).

f. Connect the 1× probe from the external trigger input connector to test point TP344. (Collector of Q344).

g. Check that the ramp starts just after the sixth equalizing pulse.

h. Adjust by first rotating the FIELD 1 SYNC control (R360; see Fig. 6-25) fully counterclockwise. Then, rotate the control slowly in a clockwise direction until the ramp starts just after the sixth equalizing pulse (see Fig. 6-26a). The sixth equalizing pulse is the last pulse in the equalizing-pulse group following the vertical sync pulses. Fig. 6-26b and 6-26c show two possible displays that can be obtained when the control is incorrectly adjusted.

i. Disconnect the 10× and 1× probes.

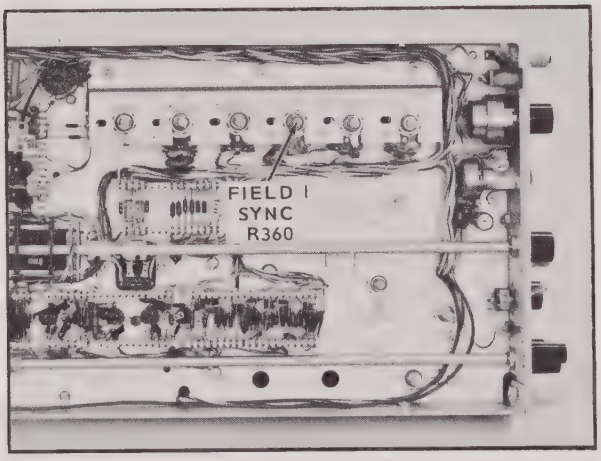


Fig. 6-25. Location of FIELD 1 SYNC adjustment.

21. Check FIELD Switch

a. Test equipment setup is given in step 20.

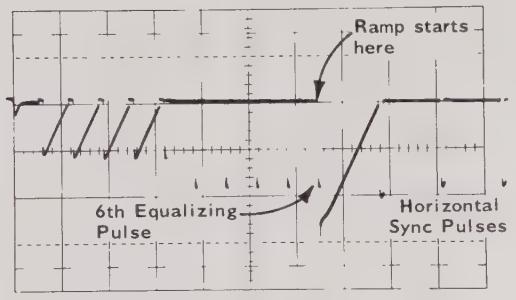
b. Set the FIELD switch to TWO.

NOTE

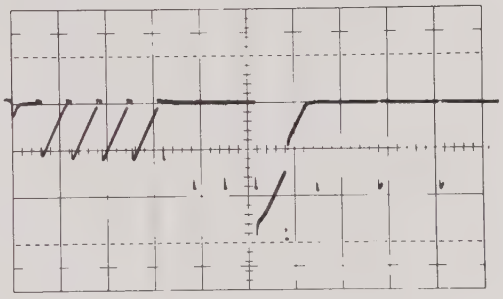
If vertical sync pulse is not completely displayed, position it to the horizontal center of the viewing area with the (HORIZ) POSITION control.

c. Check for a horizontal distance of 1 H (63.5 μs) between the last horizontal sync pulse and the first equalizing pulse (see Fig. 6-27a). This indicates that field one is displayed at the center of the crt.

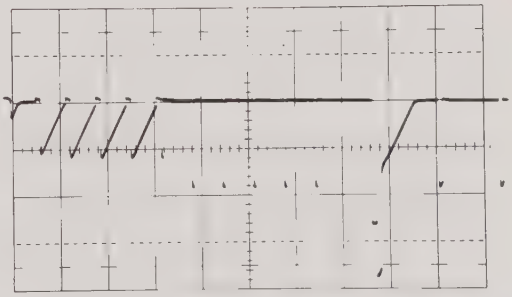
d. Set the SYNC switch to EXT and back to INT several times to check that field display is obtained each time the SYNC switch is returned to the INT position. This is a double check on step 20. A stable display of field one means that R360 is adjusted properly.



(a) Correct display.



(b) Incorrect display; control R360 set too far counterclockwise.



(c) Incorrect display; control R360 set too far clockwise.

Fig. 6-26. Adjusting the FIELD 1 SYNC control (R360) for proper triggering. Displays obtained on the test oscilloscope CRT.

e. Set the FIELD switch to one.

f. Check for 0.5 H (31.75 μs) horizontal distance between the last horizontal sync pulse and the first equalizing pulse (see Fig. 6-27b). This indicates that field two is displayed at the center of the crt.

g. Repeat part d, except check that a field two display is obtained each time the SYNC switch is returned to INT.

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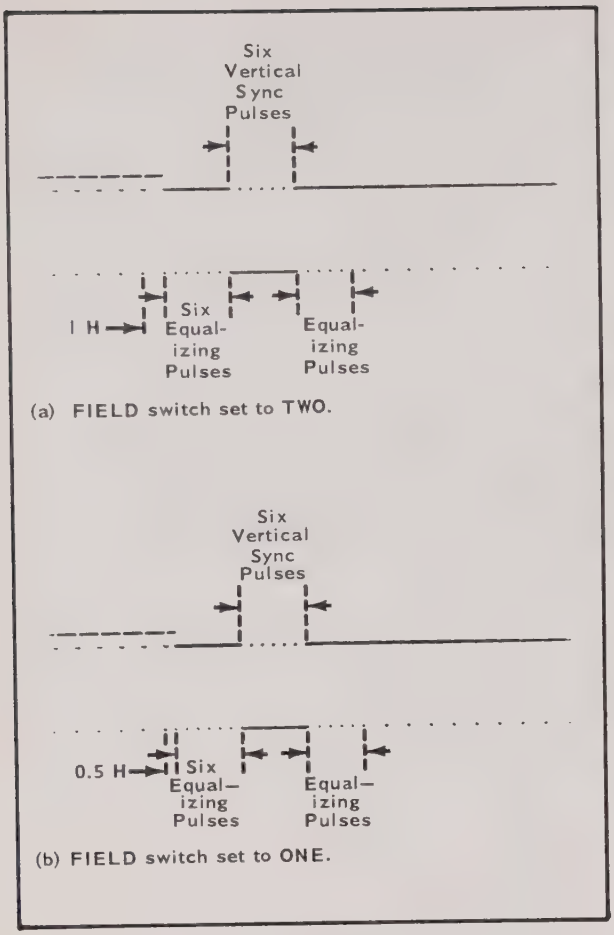

Fig. 6-27. Checking for proper field display when operating the FIELD and SYNC switches.

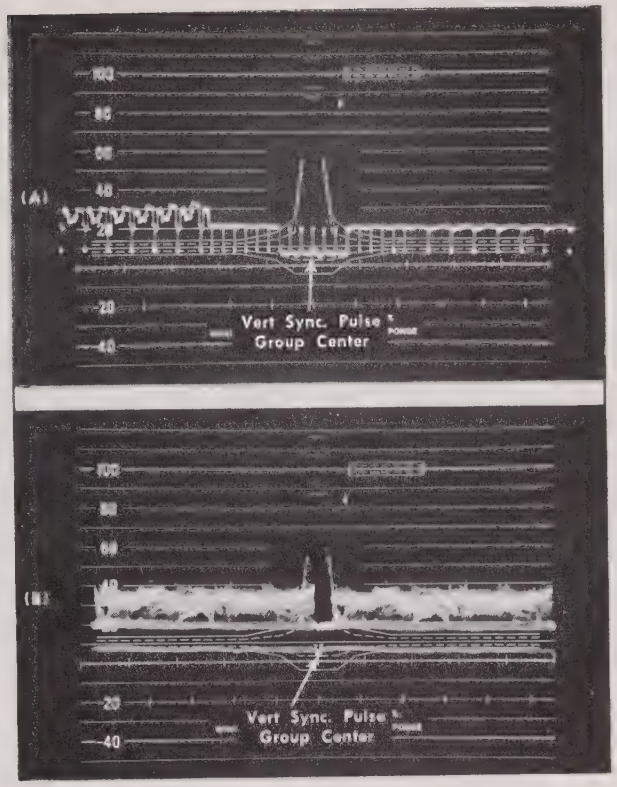

Fig. 6-28. Adjusting the SWP/MAG REGIS control (R575) for proper display registration. The Horizontal MAG switch was set to (A) ×25, (B) ×1.

22. Adjust SWP/MAG REGIS (R575)

a. Test equipment setup is given in step 20.

b. Using the (HORIZ) POSITION control, position the display so the center of the vertical-sync pulse group coincides with graticule center (see Fig. 6-28a).

c. Set the (HORIZ) MAG switch to ×1.

d. Check that vertical-pulse group coincides with graticule center (see Fig. 6-28b).

e. Adjust the SWP/MAG REGIS control (R575; see Fig. 6-29) so the vertical pulse group coincides with graticule center (see Fig. 6-28b).

f. To check if the adjustment has been set properly, set the (HORIZ) MAG switch to ×25 and then to ×1. If the display as observed at graticule center shifts horizontally, readjust the SWP/MAG REGIS control (R575) for no horizontal shift of the display when switching from ×25 to ×1.

g. Disconnect the composite video signal.

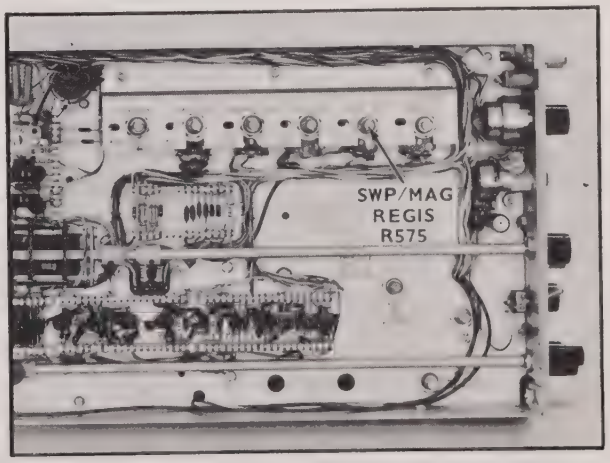

Fig. 6-29. Location of SWP/MAG REGIS adjustment.

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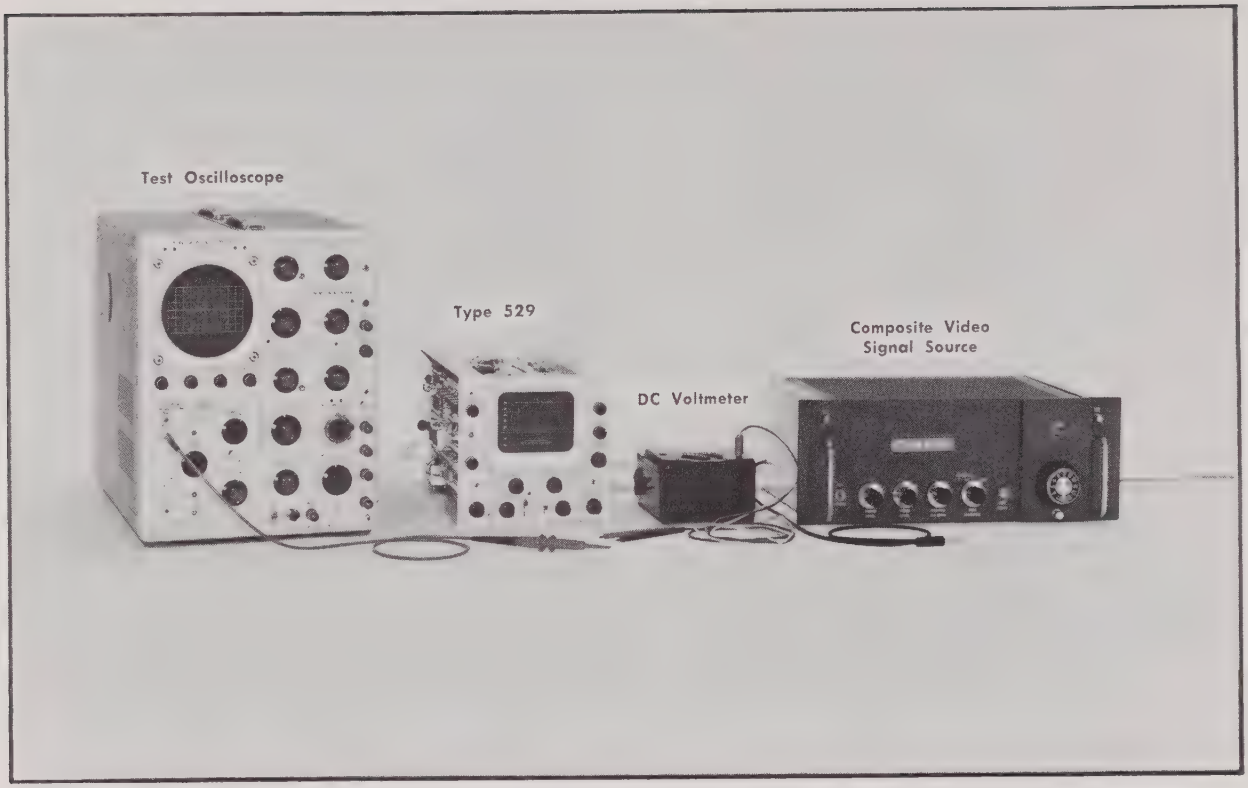

Fig. 6-30. Test equipment required for steps 23 through 25.

POWER and SCALE ILLUM	2/3 clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	OFF
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F.S.
POSITION	Midrange

HORIZONTAL Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	LINE SELECTOR .125 H/CM
FIELD	TWO
VARIABLE LINE SELECTOR	Midrange
LINE SELECTOR Switch	21

23. Check Line Selector Brightening Pulse Amplitude

a. Test equipment setup is shown in Fig. 6-30.

b. Apply one volt of composite video to the right VIDEO INPUTS A connector.

c. Connect a 75-ohm termination to the left VIDEO INPUTS A connector.

d. Connect a 75-ohm coaxial cable from the VIDEO OUTPUT connector of the Type 529 to the vertical input connector of the test oscilloscope.

e. Connect a 1× probe from the appropriate Trigger Input connector of the test oscilloscope to the junction of D377 and D387 (see Fig. 6-31).

f. Set the test oscilloscope controls as follows:

Input Selector	AC
Volts/Div	0.2
Time/Div	2 ms
Triggering Mode	Adjusted for stable display
Trigger Slope	+ External

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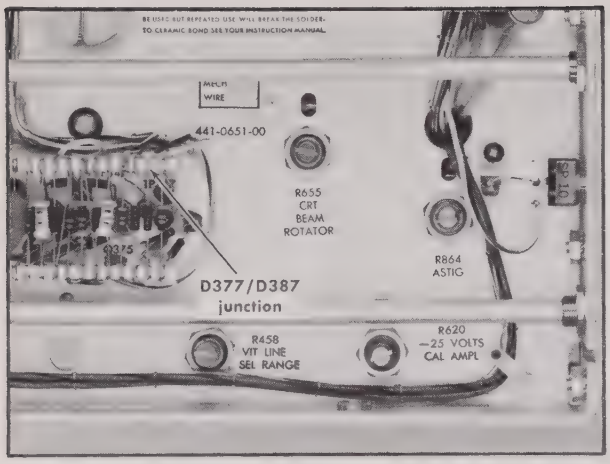

Fig. 6-31. Location of D377/D387 junction.

NOTE

The external triggering signal must be at the video field rate.

g. Check that the brightening pulse amplitude is at least 100 mV high.

24. Adjust VIT LINE SEL RANGE (R458); SN 998-up

a. Test equipment setup is given in step 23.

b. Connect a DC voltmeter between the center arm of R458 and ground.

NOTE

Before proceeding with this step, the position of the LINE SELECTOR should be checked to insure that the knob has not been misaligned.

c. Adjust the VIT LINE SEL RANGE control (R458; see Fig. 6-32) so the brightening pulse just starts to jump between the 21st and 22nd lines as observed on the test oscilloscope.

NOTE

LINE 10 starts at the first horizontal pulse following the last equalizing pulse in both fields (field one and two). Lines 16 through 21 can be found by counting forward from this point of reference.

d. Note the DC voltmeter reading.

e. Adjust the VIT LINE SEL RANGE control (R458) so the brightening pulse just starts to jump between the 21st and 20th lines as observed on the test oscilloscope.

f. Note the DC voltmeter reading.

g. Adjust the VIT LINE SEL RANGE control (R458) for a DC voltmeter reading half way between the two readings noted in parts d and f of this step.

h. Disconnect the DC voltmeter.

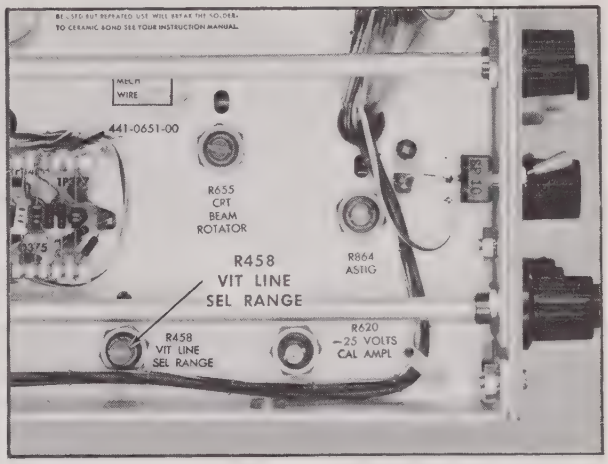

Fig. 6-32. Location of VIT LINE SEL RANGE control (R458).

25. Check Line Selector Operation; SN 998-up

a. Test equipment setup is given in step 23.

b. Set the LINE SELECTOR switch to VARIABLE and rotate the VARIABLE (LINE SELECTOR) control fully counterclockwise.

c. Check the position (in time) of the brightening pulse on the test oscilloscope. The brightening pulse must start on or before the 15th line.

d. Rotate the VARIABLE (LINE SELECTOR) control fully clockwise.

e. Check the position (in time) of the brightening pulse on the test oscilloscope. The brightening pulse must start after the first 25% of the second field.

f. Set the LINE SELECTOR switch to each numbered line position.

g. Check that the brightening pulse starts at the start of the line that the LINE SELECTOR switch is set to.

h. Set the FIELD switch to ONE and repeat parts b through g.

NOTE

LINE 10 starts at the first horizontal pulse following the last equalizing pulse in both fields (field one and two). Lines 16 through 21 can then be found by counting forward from this point of reference.

i. Disconnect the composite video signal and the test oscilloscope from the Type 529.

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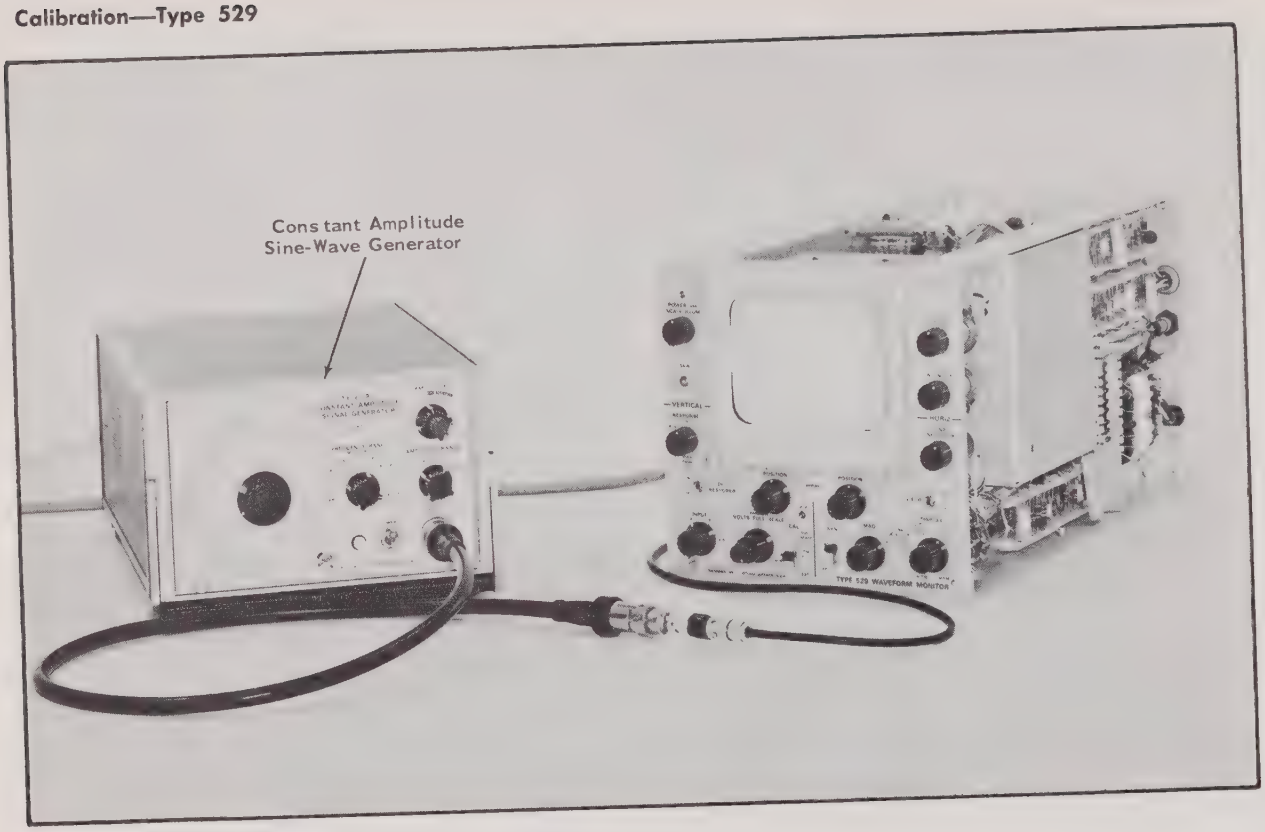

Fig. 6-33. Test equipment setup for steps 26 through 31.

POWER and SCALE ILLUM	2/3 clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange
VERTICAL Controls	
RESPONSE	FLAT
DC RESTORER	OFF
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F.S.
POSITION	Midrange
HORIZ Controls	
POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	2 FIELD
FIELD	ONE
VARIABLE LINE SELECTOR	Midrange
LINE SELECTOR Switch	VARIABLE

26[3]. Check Vertical Amplifier High-Frequency Response

a. Test equipment setup is shown in Fig. 6-33.

b. Apply a 50-kHz sine wave signal from the constant amplitude sine-wave generator, to the VIDEO INPUTS A connector.

c. Adjust the constant amplitude sine-wave generator for 100 IEEE units of vertical deflection; this is the reference amplitude.

d. Follow the remaining sequence of instructions given in Table 6-2 to check the vertical-amplifier frequency response and rolloff for all the front panel control positions listed.

27. Adjust Vertical-Amplifier 1.0 Flat-Frequency Response (C269, L162 and L262)

a. Test equipment setup is given in step 26.

b. Check the vertical-amplifier response from 500 kHz to 8 MHz. It should be flat within +0%, —1% to 5 MHz and flat to within +0%, —3% to 8 MHz.

c. Adjust the vertical-amplifier components (see Fig. 6-34) as listed in Table 6-3 to obtain flat-frequency response from 500 kHz to 8 MHz within +0%, —1% to 5 MHz, +0%, —3% to 8 MHz.

[3]An optional method of checking high-frequency response of the vertical amplifier will be found in step 34.

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TABLE 6-2

Checking Vertical Amplifier Frequency Response

RESPONSE Switch Set To:	Signal[4] To: INPUT Switch Set To:	VARIABLE (VOLTS FULL SCALE) Set To:	(VERTICAL) VOLTS FULL SCALE) Switch Set To:	Check or Procedure
FLAT	A	CALIB	1.0	Check for flat frequency response from 500 kHz to 8 MHz[5]; within +0%, —1% (—0.1 dB) or 1 IEEE unit to 5 MHz, +0%, —3% (—0.3 dB) or 3 units to 8 MHz.
			0.2 0.5	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.
		Fully Counter-clockwise		Check for flat frequency response from 500 kHz to 5 MHz[6]; within +0%, —1% (—0.1 dB) or 1 IEEE unit.
			1.0	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.
	B	CALIB	1.0	Check for flat frequency response from 500 kHz to 8 MHz; within +0%, —1% (—0.1 dB) to 5 MHz, +0%, —3% (—0.3 dB) to 8 MHz.
LOW PASS	A	CALIB	1.0	Set the constant amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz. Check for vertical deflection of 25 units or less at 500 kHz.
FLAT	A	CALIB	1.0	[7]Set the constant amplitude sine wave generator for 100 IEEE units of reference amplitude at 50 kHz.
HIGH PASS	A	CALIB	1.0	Check for exactly 100 IEEE units of vertical deflection at 3.58 MHz (center frequency); 65 to 85 units at 3.18 MHz and 3.98 MHz.[8]
IEEE	A	CALIB	1.0	Set the constant amplitude sine-wave generator for 1000 IEEE units of vertical deflection at 50 kHz. Check high-frequency rolloff at the following points: At 350 kHz-94 to 97.5 units. At 1 MHz-70 to 80 units. At 2 MHz-31.2 to 42.5 units. At 3.6 MHz-5.6 to 14 units.

[4]Apply the signal to the right VIDEO INPUT connector as indicated in the column and terminate the appropriate left VIDEO INPUT connector with a 75-ohm termination.
[5]If frequency response cannot be obtained within the tolerance specified, perform step 27 before completing the checks given in the remaining portion of Table 6-2.
[6]If frequency response within the tolerance cannot be obtained for the 0.2 and 0.5 vertical VOLTS FULL SCALE switch position, perform step 28 for the 0.2 position and step 29 for 0.5.
[7]This is a preliminary setup procedure for performing the high-pass frequency-response check that follows.
[8]If this frequency-response characteristic cannot be met, perform step 30.

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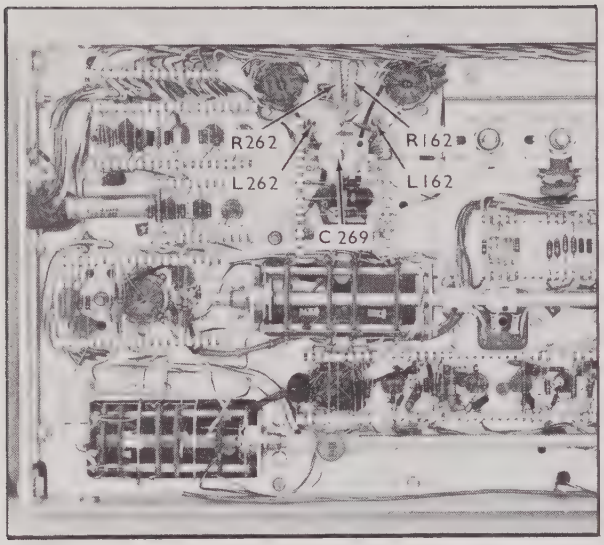

Fig. 6-34. Location of C269, R162-R262 and coils L162 and L262.

TABLE 6-3

Vertical Amplifier Flat-Frequency Response Adjustments Shown in Fig. 6-34

Adjustment C269	Affects Frequency Response In These Frequency Ranges
C269	2 to 6 MHz, particularly at 2.5 MHz
Physical spacing of R162 and R262	3 to 6 MHz, particulary at 4 MHz
L162 and L262 Slugs	5 to 10 MHz

d. Recheck the response between 500 kHz and 8 MHz at several points to determine if any of the adjustments in the step need to be readjusted to obtain the desired response.

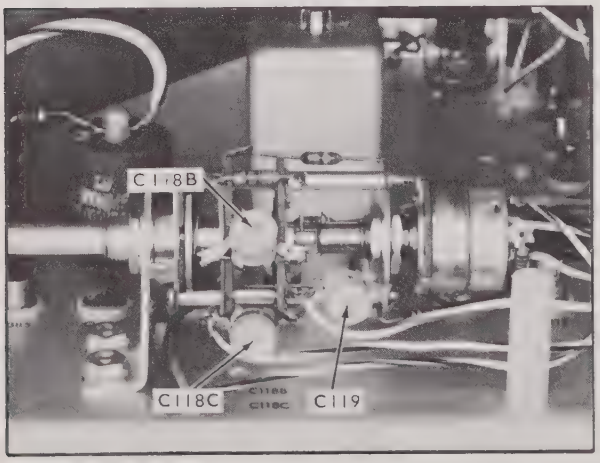

Fig. 6-35. Location of C118B, C118C, and C119 adjustment.

28. Adjust Vertical-Amplifier 0.2 Flat-Frequency Response (C118B)

a. Test equipment setup is given in step 26.

b. Set the (VERTICAL) VOLTS FULL SCALE switch to 0.2.

c. Set the constant-amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.

d. Check for a flat-frequency response within +0%, —1% from 500 kHz to 5 MHz.

e. Adjust C118B (see Fig. 6-35) to obtain flat-frequency response from 500 kHz to 5 MHz within +0%, —1%.

29. Adjust Vertical-Amplifier 0.5 Flat-Frequency Response (C118C)

a. Test equipment setup is given in step 26.

b. Set the (VERTICAL) VOLTS FULL SCALE switch to 0.5.

c. Set the constant-amplitude sine-wave generator for 100 IEEE units of reference amplitude at 50 kHz.

d. Check for a flat-frequency response within +0%, —1% from 500 kHz to 5 MHz.

e. Adjust C118C (see Fig. 6-35) to obtain flat-frequency response from 500 kHz to 5 MHz within +0%, —1%.

30. Adjust Common Mode Rejection

a. Test equipment setup is given in step 26.

b. Disconnect the constant-amplitude sine-wave generator from the A VIDEO INPUT connector.

c. Connect a female to female BNC adapter to the constant-amplitude sine-wave generator 50 ohm GR to BNC termination and a BNC T connector to the female to female BNC adapter. Connect a 75 ohm coaxial cable from one end of the T connector to the right A VIDEO INPUT connector. Connect another 75 ohm coaxial cable from the other end of the T connector to the right B VIDEO INPUT connector.

d. Connect a 75 ohm termination to the left B VIDEO INPUT connector.

e. Set the VOLTS FULL SCALE switch to 1.0.

f. Apply 40 IEEE units of 2 MHz signal from the constant-amplitude sine wave generator to the Type 529.

g. Set the INPUT switch to A-B.

h. Adjust C119 (see Fig. 6-35) for minimum display amplitude. If desired the VOLTS FULL SCALE switch may be set to provide a larger signal.

i. Recheck steps 26 through 29 and this step several times to eliminate any interaction.

j. Remove the female to female BNC adapter, the BNC T connector and the two 75 ohm cables. Remove the 75 ohm termination from the lower B VIDEO INPUT connector and reconnect the constant-amplitude sine-wave generator to the right A VIDEO INPUT connector.

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31. Adjust Vertical-Amplifier Chroma Frequency Response (T135)

a. Test equipment setup is given in step 26.

b. Set the RESPONSE switch to FLAT and the VOLTS FULL SCALE switch to 1.0.

c. Set the constant-amplitude sine wave generator for 100 IEEE units of reference amplitude at 50 kHz.

d. Set the constant-amplitude sine wave generator for an output frequency of 3.58 MHz.

e. Set the RESPONSE switch to HIGH PASS.

f. Check for 100 IEEE units of vertical deflection.

g. Adjust the bottom powder-iron slug in T135 (see Fig. 6-36) to obtain 100 IEEE units of vertical deflection.

h. Set the constant-amplitude sine wave generator for an output frequency of 3.18 MHz.

i. Check for 65 to 85 IEEE units of vertical deflection.

j. Adjust the top slug in T135 to obtain 65 to 85 IEEE units of vertical deflection.

k. Set the constant-amplitude sine-wave generator for an output frequency of 3.98 MHz.

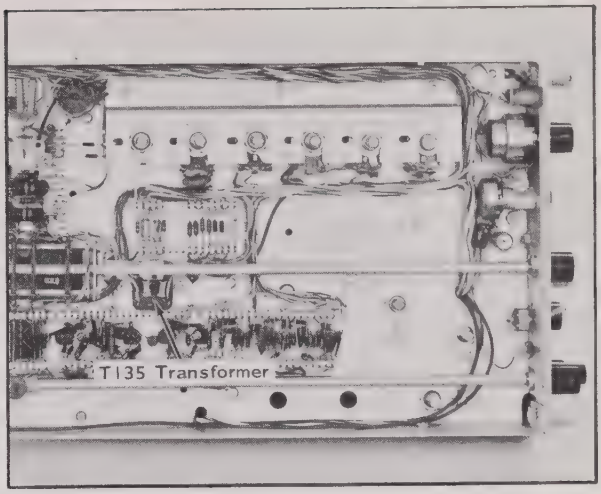

Fig. 6-36. Location of transformer T135.

l. Check that the vertical deflection of the display is 65 to 85 IEEE units in amplitude. If necessary, repeat steps d through k to obtain proper frequency response characteristics.

m. After completing the adjustment of T135 and the checks in Table 6-2, disconnect the constant-amplitude sinewave generator from the Type 529.

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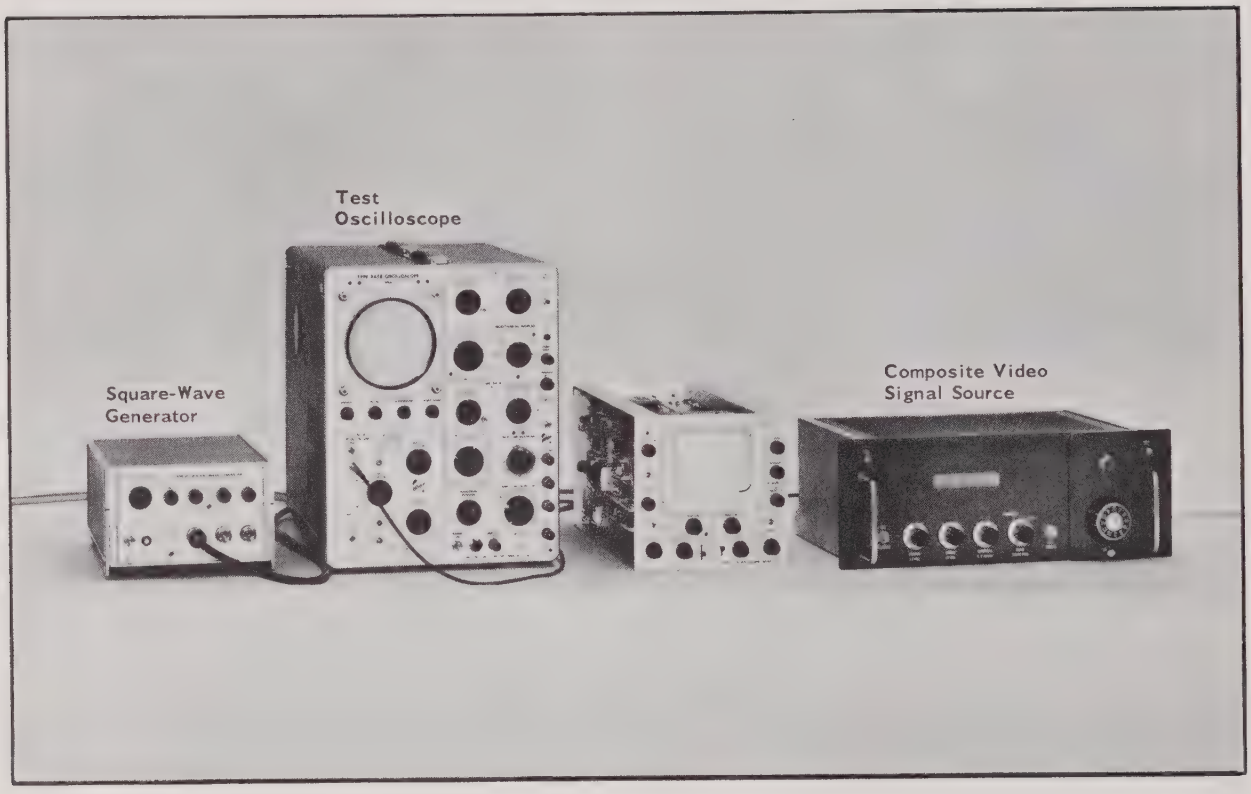

Fig. 6-37. Test equipment setup for steps 32 and 33.

POWER and SCALE ILLUM	⅔ clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	Midrange

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	ON
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F.S.
POSITION	Midrange

HORIZ Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	2 LINE
FIELD	ONE
VARIABLE LINE SELECTOR	Midrange
LINE SELECTOR Switch	VARIABLE

32. Check J501 Staircase Input

a. Test equipment setup is shown in Fig. 6-37.

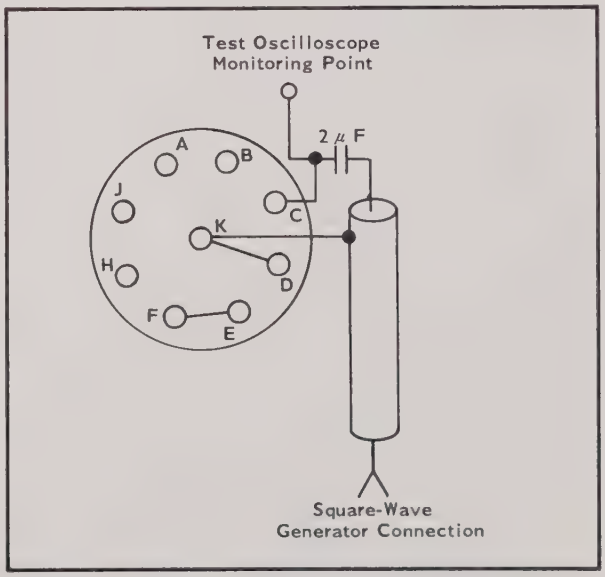

Fig. 6-38. Front view of 9-pin connector (Tektronix Part No. 134-0049-00) showing wire jumper connections to cause relay K501 to be energized whenever the plug is in place.

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b. Wire the 9-pin plug connector (Tektronix Part No. 134-0049-00) as shown in Fig. 6-38. Make sure that the 2-μF capacitor is in series between the Type 529 J501 connector pin C and the output of the square-wave generator.

c. Connect the plug to J501 on the Type 529.

d. Connect a 12-volt, 120-hertz signal from a square-wave generator to pin C of the plug via the 2-μF capacitor.

e. Connect a test oscilloscope to the monitoring point to measure the output amplitude of the square-wave generator.

f. Apply one volt of composite video to the right VIDEO INPUTS A connector.

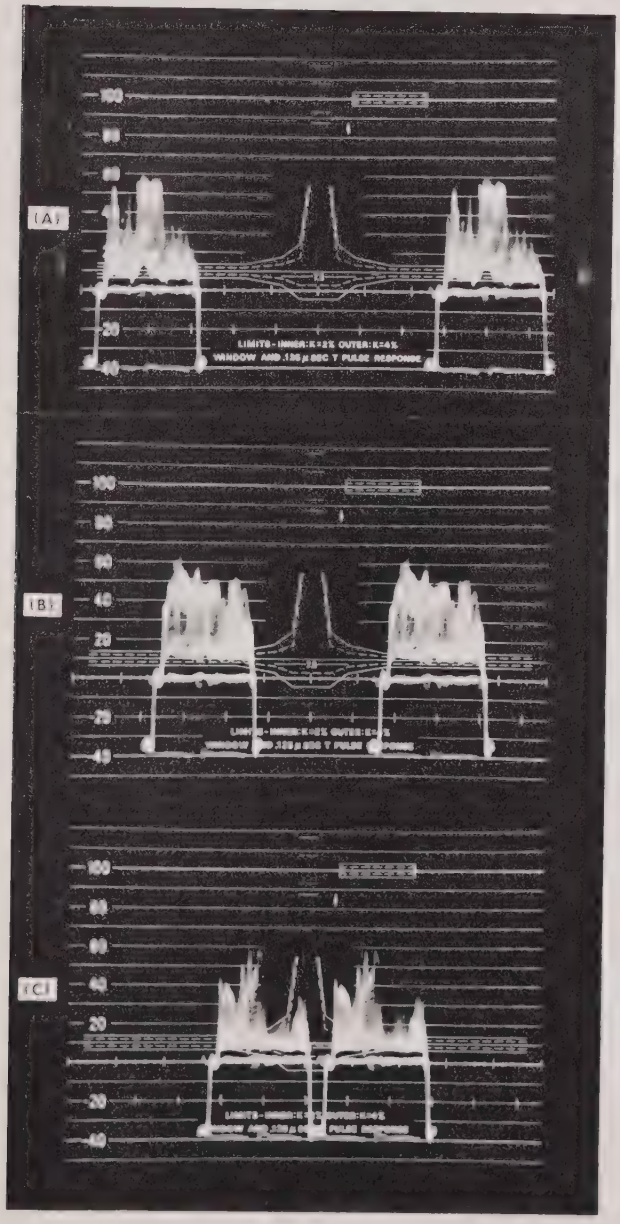

Fig. 6-39. Checking to insure that a four display per 10 centimeter presentation can be obtained.

g. Connect a 75-ohm termination to the left VIDEO INPUTS A connector.

h. Check for a display as shown in Fig. 6-39A. Note right-hand display position.

i. Reduce the signal from the square-wave generator to 8 volts.

j. Check for a display as shown in Fig. 6-39B. Note right-hand display position.

k. Reduce the signal from the square-wave generator to 4 volts.

l. Check for a display as shown in Fig. 6-39C. Note right-hand display position.

m. Check that each display had some separation from its neighbors.

33. Adjust Bar Response of Pulse and Bar VIT Signal ◐

a. Test equipment setup is given in step 32.

b. Connect 1-volt composite video signal to the right A VIDEO INPUTS connector.

c. Check that a 75-ohm termination is connected to the left A VIDEO INPUTS connector.

d. Set the Type 529 front-panel controls as follows:

POWER and SCALE ILLUM	2/3 clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brightness
GAIN	As is

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	ON
INPUT	A

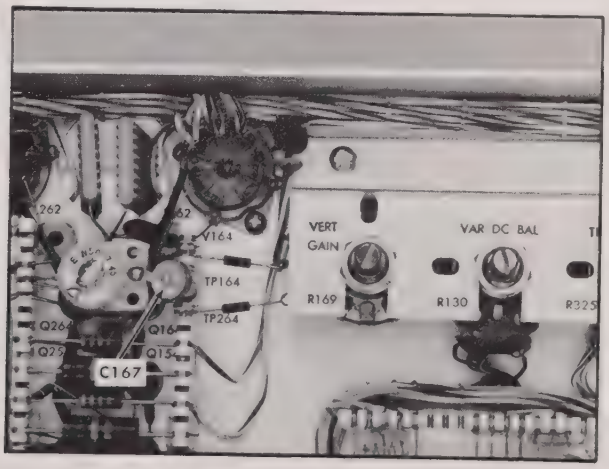

Fig. 6-40. Location of C167.

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VOLTS FULL SCALE VARIABLE (VOLTS FULL SCALE)	Adjusted for 100 IEEE units of pulse and bar VIT pulse
CAL	.714 F.S.
POSITION	Midrange

HORIZ Controls

POSITION	Midrange
SYNC	INT
MAG	×1
DISPLAY	LINE SELECTOR .125 H/CM
VARIABLE LINE SELECTOR	Midrange
FIELD	Set as required to obtain pulse and bar VIT signal

e. Adjust C167 (see Fig. 6-40) for optimum flat top, i.e., no tilt of bar top, of the bar portion of the pulse and bar VIT signal.

NOTES

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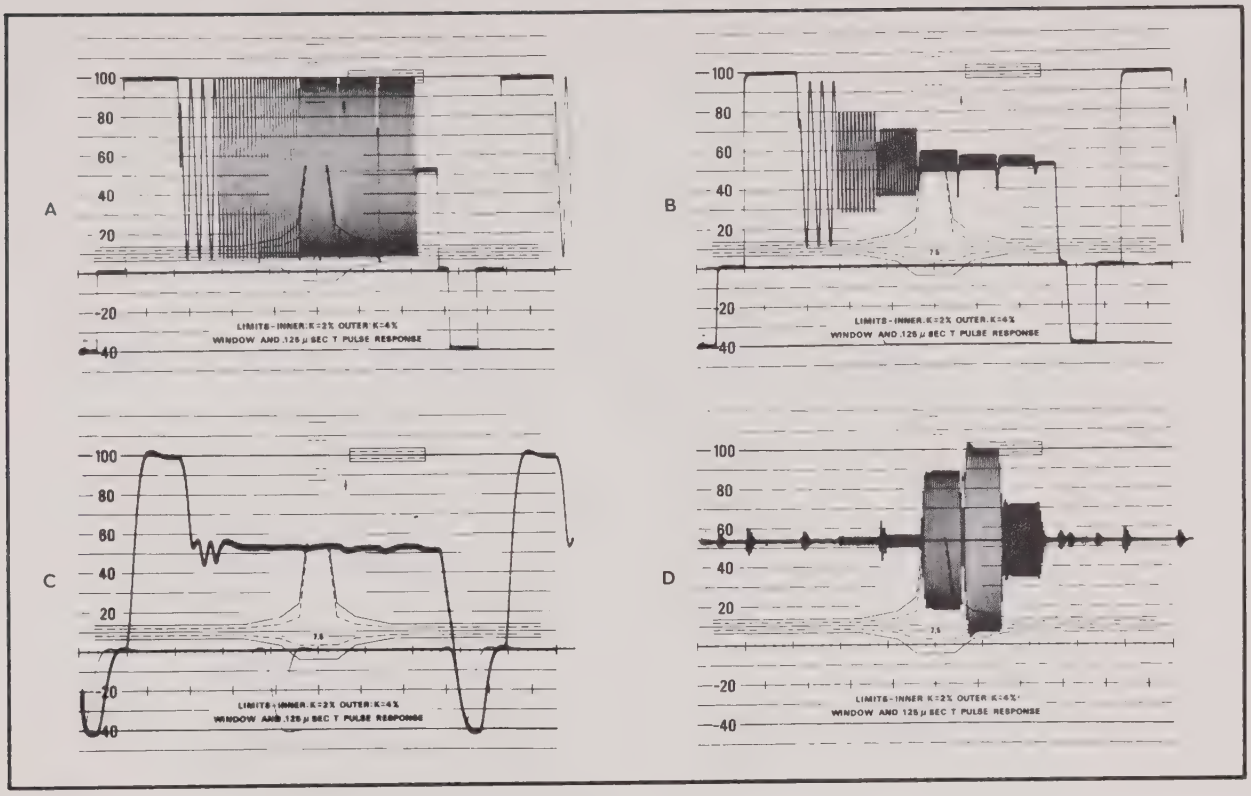

Fig. 6-41. Waveforms showing the display which will result when 1-volt of multi-burst signal is connected to the Type 529 and the RESPONSE switch is set to (A) FLAT, (B) IEEE, (C) LOW PASS and (D) HIGH PASS.

34. (Optional Method) Check Vertical Amplifier High-Frequency Response

POWER and SCALE ILLUM	2/3 clockwise
FOCUS	Midrange
INTENSITY	Adjust for normal display brigtness
GAIN	Midrange

VERTICAL Controls

RESPONSE	FLAT
DC RESTORER	ON
INPUT	A
VOLTS FULL SCALE	1.0
VARIABLE (VOLTS FULL SCALE)	CALIB
CAL	.714 F.S.
POSITION	Midrange

HORIZ Controls

POSITION	Midrange
SYNC	INT
MAG	X1
DISPLAY	.125 H/CM
FIELD	ONE
VARIABLE (LINE SELECTOR)	Midrange
LINE SELECTOR Switch	VARIABLE

a. Connect to right VIDEO INPUTS A connector 1 volt of multi-burst signal.

b. Connect a 75-ohm termination to the left VIDEO INPUTS A connector.

c. Check each position of the RESPONSE switch for the display shown in Fig. 6-41.

This completes the calibration of the Type 529. Disconnect all test equipment. If the instrument has been completely calibrated to the tolerances given in this procedure, it will perform to the limits given in the characteristics section of this Instruction Manual.

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NOTES

PARTS LIST ABBREVIATIONS

BHB	binding head brass
BHS	binding head steel
cap.	capacitor
cer	ceramic
comp	composition
conn	connector
CRT	cathode-ray tube
csk	countersunk
DE	double end
dia	diameter
div	division
elect.	electrolytic
EMC	electrolytic, metal cased
EMT	electrolytic, metal tubular
ext	external
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
h	height or high
hex.	hexagonal
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
ID	inside diameter
incd	incandescent
int	internal
lg	length or long
met.	metal
mtg hdw	mounting hardware
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
PHB	pan head brass
PHS	pan head steel
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
RHB	round head brass
RHS	round head steel
SE	single end
SN or S/N	serial number
SW	switch
TC	temperature compensated
THB	truss head brass
thk	thick
THS	truss head steel
tub.	tubular
var	variable
w	wide or width
WW	wire-wound

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

×000	Part first added at this serial number
00×	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.
	Screwdriver adjustment.
	Control, adjustment or connector.

SECTION 7
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description				S/N Range
		Bulbs				
B242	150-0035-00	Neon, A1D T2	CAL			
B604	150-0001-00	Incandescent, #47	Graticule Light			
B605	150-0001-00	Incandescent, #47	Graticule Light			
B864	150-0030-00	Neon, NE-2 V				100-5999X
B865	150-0030-00	Neon, NE-2 V				100-5999X
B866	150-0030-00	Neon, NE-2 V	POWER (ON)			
		Capacitors				
Tolerance ±20% unless otherwise indicated.						
C101	281-0509-00	15 pF	Cer	500 V	10%	
C104	285-0623-00	0.47 μF	PTM	100 V		
C106	283-0001-00	0.005 μF	Cer	500 V		
C113	281-0604-00	2.2 pF	Cer	500 V	±0.25 pF	100-3452
C113	281-0592-00	4.7 pF	Selected (nominal value)			3453-up
C118B	281-0061-00	5.5-18 pF	Cer Var			
C118C	281-0063-00	9-35 pF	Cer Var			
C118D	281-0509-00	15 pF	Cer	500 V	10%	
C119	281-0060-00	2-8 pF	Cer Var			
C122	283-0027-00	0.02 μF	Cer	30 V		100-5999
C122	283-0004-00	0.02 μF	Cer	150 V		6000-up
C124	283-0079-00	0.01 μF	Cer	250 V		
C130	283-0006-00	0.02 μF	Cer	500 V		
C131	285-0622-00	0.1 μF	PTM	100 V		X6000-up
C132	281-0599-00	1 pF	Cer	200 V	±0.25 pF	X6000-up
C133	281-0599-00	1 pF	Cer	200 V	±0.25 pF	100-5999
C133	283-0533-00	39 pF	Mica	500 V	5%	6000-up
C134	281-0629-00	33 pF	Selected (nominal value)			100-3559
C134	281-0511-00	22 pF	Selected (nominal value)			3560-5999
C134	283-0652-00	150 pF	Mica		1%	6000-up
C135	281-0620-00	21 pF	Cer	500 V	1%	100-5999
C135	283-0620-00	470 pF	Mica	300 V	1%	6000-up
C136	283-0600-00	43 pF	Mica	500 V	5%	100-3809
C136	283-0602-00	53 pF	Mica	300 V	5%	3810-up
C137	281-0503-00	8 pF	Cer	500 V	±0.5 pF	100-3809X
C138	281-0594-00	150 pF	Cer	500 V	5%	100-5999
C138	283-0635-00	51 pF	Mica	100 V	1%	6000-up
C139	283-0594-00	0.001 μF	Mica	100 V	1%	100-5999
C139	283-0599-00	98 pF	Mica	500 V	5%	6000-up
C144	281-0558-00	18 pF	Cer	500 V		
C160	283-0001-00	0.005 μF	Cer	500 V		
C163	283-0000-00	0.001 μF	Cer	500 V		

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
C165	283-0001-00	0.005 μF	Cer		500 V		100-5999X
C167	281-0063-00	9-35 pF	Cer	Var			
C183	281-0523-00	100 pF	Cer		350 V		
C198	290-0217-00	250 uF	EMT		12 V		
C201	281-0509-00	15 pF	Cer		500 V	10%	
C204	285-0623-00	0.47 μF	PTM		100 V		
C206	283-0001-00	0.005 μF	Cer		500 V		
C213	281-0604-00	2.2 pF	Cer		500 V	±0.25 pF	100-3452
C213	281-0592-00	4.7 pF		Selected	(nominal value)		3453-up
C232	281-0097-00	9-35 pF	Cer	Var			X6000-up
C233	283-0552-00	200 pF	Mica		500 V	1%	X6000-up
C234	283-0654-00	790 pF	Mica		100 V	1%	X6000-up
C235	283-0620-00	470 pF	Mica		300 V	1%	X6000-up
C236	283-0600-00	43 pF	Mica		500 V	5%	100-3809
C236	283-0602-00	53 pF	Mica		300 V	5%	3810-up
C237	281-0503-00	8 pF	Cer		500 V	±0.5 pF	100-3809X
C238	283-0635-00	51 pF	Mica		100 V	1%	X6000-up
C239	281-0092-00	9-35 pF	Cer	Var			X6000-up
C241	281-0513-00	27 pF		Selected	(nominal value)		X2069-up
C244	281-0558-00	18 pF	Cer		500 V		
C263	283-0000-00	0.001 μF	Cer		500 V		
C265	283-0001-00	0.005 μF	Cer		500 V		100-5999X
C267	281-0513-00	27 pF	Cer		500 V		
C269	281-0012-00	7-45 pF	Cer	Var			
C274	281-0578-00	18 pF	Cer		500 V	5%	X6000-up
C275	283-0113-00	56 pF	Cer		500 V	1%	X6000-up
C281	283-0026-00	0.2 μF	Cer		25 V		
C285	281-0602-00	68 pF	Cer		500 V	5%	
C286	281-0602-00	68 pF	Cer		500 V	5%	
C292	283-0001-00	0.005 μF	Cer		500 V		
C293	283-0001-00	0.005 μF	Cer		500 V		
C294	281-0523-00	100 pF	Cer		350 V		
C297	283-0000-00	0.001 μF	Cer		500 V		
C301	283-0002-00	0.01 μF	Cer		500 V		100-2529
C301	285-0622-00	0.1 μF	PTM		100 V		2530-up
C302	281-0543-00	270 pF	Cer		500 V	10%	X1830-up
C303	283-0041-00	0.0033 μF	Cer		500 V	5%	X1830-up
C304	283-0104-00	0.002 μF	Cer		500 V		100-1829
C304	283-0596-00	528 pF	Mica		300 V	1%	1830-up
C317	281-0525-00	470 pF	Cer		500 V		100-1829
C317	283-0059-00	1 μF	Cer		25 V	+80%—20%	1830-up
C327	281-0521-00	56 pF	Cer		500 V	10%	100-1829
C327	281-0516-00	39 pF	Cer		500 V	10%	1830-up
C328	281-0504-00	10 pF	Cer		500 V	10%	100-1829X
C333	283-0004-00	0.02 μF	Cer		150 V		
C335	281-0623-00	650 pF	Cer		500 V	5%	100-1829
C335	281-0546-00	330 pF	Cer		500 V	10%	1830-up
C341	283-0000-00	0.001 μF	Cer		500 V		
C342	283-0001-00	0.005 μF	Cer		500 V		
C347	281-0523-00	100 pF	Cer		350 V		
C351	281-0513-00	27 pF	Cer		500 V		

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
C360	285-0598-00	0.01 μF	PTM	100V	5%	100-1599
C360	283-0593-00	0.01 μF	Mica	100 V	1%	1600-2109
C360	283-0593-01	0.01 μF	Mica	100 V	5%	2110-up
C361	Use 281-0534-00	3.3 pF	Cer	500 V	±0.25 pF	
C364	283-0596-00	528 pF	Mica	300 V	1%	
C370	281-0546-00	330 pF	Cer	500 V	10%	
C371	283-0081-00	0.1 μF	Cer	25 V		
C372	281-0550-00	120 pF	Cer	500 V	10%	X1600-up
C374	283-0000-00	0.001 μF	Cer	500 V		
C375	283-0000-00	0.001 μF	Cer	500 V		100-1599
C375	281-0550-00	120 pF	Cer	500 V	10%	1600-up
C377	283-0000-00	0.001 μF	Cer	500 V		
C384	283-0000-00	0.001 μF	Cer	500 V		
C385	283-0000-00	0.001 μF	Cer	500 V		100-1599
C385	281-0550-00	120 pF	Cer	500 V	10%	1600-up
C387	283-0000-00	0.001 μF	Cer	500 V		
C401	281-0511-00	22 pF	Cer	500 V	10%	
C402	281-0546-00	330 pF	Cer	500 V	10%	
C409	281-0519-00	47 pF	Cer	500 V	10%	X1830-up
C412	283-0000-00	0.001 μF	Cer	500 V		
C416	285-0633-00	0.22 μF	PTM	100 V	10%	
C418	283-0001-00	0.005 μF	Cer	500 V		
C427	281-0525-00	470 pF	Cer	500 V		
C428	281-0621-00	12 pF	Cer	500 V	1%	
C431	281-0525-00	470 pF	Cer	500 V		
C439	283-0010-00	0.05 μF	Cer	50 V		
C441	281-0524-00	150 pF	Cer	500 V		
C449	283-0000-00	0.001 μF	Cer	500 V		
C452	281-0550-00	120 pF	Cer	500 V	10%	100-3915
C452	281-0543-00	270 pF	Cer	500 V	10%	3916-up
C455	281-0605-00	200 pF	Cer	500 V		100-997
C455	281-0523-00	100 pF	Cer	350 V		998-up
C461	285-0703-00	0.1 μF	PTM	100 V	5%	100-997X
C462	283-0600-00	43 pF	Mica	500 V	5%	X998-1829
C462	281-0528-00	82 pF	Cer	500 V	10%	1830-up
C463	285-0595-00	0.1 μF	PTM	100 V		X998-up
C464	281-0551-00	390 pF	Cer	500 V	10%	X1000-up
C465	281-0518-00	47 pF	Cer	500 V		
C469	283-0026-00	0.2 μF	Cer	25 V		X6000-up
C470	281-0551-00	390 pF	Cer	500 V	10%	100-997
C470	281-0523-00	100 pF	Cer	350 V		998-up
C477	283-0096-00	500 pF	Cer	20000 V		100-2529
C477	281-0556-00	500 pF	Cer	10000 V		2530-3849
C477	283-0096-01	500 pF	Cer	20000 V		3850-up
C478	283-0092-00	0.03 μF	Cer	200 V	+80%—20%	100-5999
C478	283-0002-00	0.01 μF	Cer	500 V	+80%—20%	6000-up
C481	281-0012-00	7-45 pF	Cer	Var		
C482	283-0519-00	360 pF	Mica	500 V	5%	
C483	285-0595-00	0.1 μF	PTM	100 V	1%	
C484	Use 283-0028-00	0.0022 μF	Cer	50 V		100-5999
C484	283-0001-00	0.005 μF	Cer	500 V		6000-up
C501	281-0616-00	6.8 pF	Cer	200 V		

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
C509	281-0613-00	10 pF	Cer	200 V	10%	
C517	283-0000-00	0.001 μF	Cer	500 V		
C520	281-0578-00	18 pF	Cer	500 V	5%	100-999
C520	281-0504-00	10 pF	Cer	500 V	10%	1000-up
C521	281-0012-00	7-45 pF	Cer Var			
C522	281-0622-00	47 pF	Cer	500 V	1%	
C523	281-0546-00	330 pF	Cer	500 V	10%	100-999X
C545	283-0000-00	0.001 μF	Cer	500 V		100-999
C545	283-0003-00	0.01 μF	Cer	150 V		1000-up
C568	285-0627-00	0.0033 μF	PTM	100 V	1%	100-999X
C575	283-0026-00	0.2 μF	Cer	25 V		100-999
C575	283-0059-00	1 μF	Cer	25 V	+80%—20%	1000-up
C610	290-0122-00	1000 μF	EMC	50 V		
C617	283-0002-00	0.01 μF	Cer	500 V		
C620	290-0145-00	10 μF	EMT	50 V		
C626	283-0003-00	0.01 μF	Cer	150 V		
C640	290-0180-00	300 μF	EMC	250 V		
C644	283-0079-00	0.01 μF	Cer	250 V		
C646	Use 285-0572-00	0.1 μF	PTM	200 V		
C649	290-0149-00	5 μF	EMT	150 V		
C650A,B	290-0059-00	160-10 μF	EMC	350 V		
C800	290-0213-00	10 μF	EMT	450 V		
C801	283-0111-00	0.1 μF	Cer	50 V		100-5999X
C804	290-0183-00	1 μF	EMT	35 V	10%	X6000-up
C805	283-0002-00	0.01 μF	Cer	500 V		X6000-up
C806	283-0002-00	0.01 μF	Cer	500 V		X6000-up
C814	290-0255-00	20 μF	EMT	50 V		
C816	283-0092-00	0.03 μF	Cer	200 V	+80%—20%	X6000-up
C818	283-0059-00	1 μF	Cer	25 V	+80%—20%	X6000-up
C819	281-0562-00	39 pF	Cer	500 V		X6000-up
C821	283-0004-00	0.02 μF	Cer	150 V		X6000-up
C822	283-0036-00	0.0025 μF	Cer	6000 V		
C832	281-0556-00	500 pF	Cer	10000 V		
C834	285-0622-00	0.1 μF	PTM	100 V		100-5999X
C836	283-0082-00	0.01 μF	Cer	4000 V	+80%—20%	X6000-up
C837	283-0034-00	0.005 μF	Cer	4000 V		100-5999X
C839	283-0034-00	0.005 μF	Cer	4000 V		100-5999X
C846	283-0082-00	0.01 μF	Cer	4000 V	+80%—20%	X6000-up
C847	283-0002-00	0.01 μF	Cer	500 V		X6000-up
C848	283-0096-00	500 pF	Cer	20000 V		100-2529
C848	281-0556-00	500 pF	Cer	10000 V		2530-3849
C848	283-0096-01	500 pF	Cer	20000 V		3850-5999X
C849	283-0006-00	0.02 μF	Cer	500 V		100-5999X
C850	281-0543-00	270 pF	Cer	500 V	10%	
C865	283-0002-00	0.01 μF	Cer	500 V		X6000-up
C875	283-0109-00	27 pF	Cer	1000 V		
C876	283-0032-00	470 pF	Cer	500 V	5%	

®

Diodes

Ckt. No.	Tektronix Part No.		Description	S/N Range
D110	*152-0185-00	Silicon	Replaceable by 1N4152	
D161	*152-0061-00	Silicon	Replaceable by 1N4152	X6000-up
D210	*152-0185-00	Silicon	Tek Spec	
D271	*152-0075-00	Germanium	Tek Spec	
D272	*152-0075-00	Germanium	Tek Spec	
D282	*152-0061-00	Silicon	Tek Spec	100-5999
D282	*152-0185-00	Silicon	Replaceable by 1N4152	6000-up
D285	*152-0185-00	Silicon	Replaceable by 1N4152	
D286	*152-0185-00	Silicon	Replaceable by 1N4152	
D292	*152-0185-00	Silicon	Replaceable by 1N4152	
D293	*152-0185-00	Silicon	Replaceable by 1N4152	
D301	*152-0185-00	Silicon	Replaceable by 1N4152	
D304	*152-0185-00	Silicon	Replaceable by 1N4152	
D314	*152-0185-00	Silicon	Replaceable by 1N4152	
D315	*152-0185-00	Silicon	Replaceable by 1N4152	X2530-up
D317	*152-0185-00	Silicon	Replaceable by 1N4152	
D318	*152-0185-00	Silicon	Replaceable by 1N4152	
D323	*152-0185-00	Silicon	Replaceable by 1N4152	X1830-up
D333	*152-0185-00	Silicon	Replaceable by 1N4152	X1830-up
D346	*152-0185-00	Silicon	Replaceable by 1N4152	
D351	*152-0185-00	Silicon	Replaceable by 1N4152	X1600-up
D362	*152-0185-00	Silicon	Replaceable by 1N4152	
D363	*152-0185-00	Silicon	Replaceable by 1N4152	X1600-up
D368	*152-0185-00	Silicon	Replaceable by 1N4152	
D370	*152-0185-00	Silicon	Replaceable by 1N4152	
D371	*152-0185-00	Silicon	Replaceable by 1N4152	
D374	*152-0185-00	Silicon	Replaceable by 1N4152	
D377	*152-0185-00	Silicon	Replaceable by 1N4152	
D384	*152-0185-00	Silicon	Replaceable by 1N4152	
D387	*152-0185-00	Silicon	Replaceable by 1N4152	
D413	*152-0185-00	Silicon	Replaceable by 1N4152	
D414	*152-0185-00	Silicon	Replaceable by 1N4152	
D415	*152-0185-00	Silicon	Replaceable by 1N4152	
D423	*152-0075-00	Germanium	Tek Spec	
D425	*152-0185-00	Silicon	Replaceable by 1N4152	
D441	*152-0185-00	Silicon	Replaceable by 1N4152	
D444	*152-0185-00	Silicon	Replaceable by 1N4152	
D452	*152-0185-00	Silicon	Replaceable by 1N4152	
D455	*152-0185-00	Silicon	Replaceable by 1N4152	
D456	*152-0185-00	Silicon	Replaceable by 1N4152	X998-up
D461	*152-0185-00	Silicon	Replaceable by 1N4152	
D462	*152-0185-00	Silicon	Replaceable by 1N4152	X998-up
D463	*152-0075-00	Germanium	Tek Spec	X998-up
D464	*152-0075-00	Germanium	Tek Spec	100-5999
D464	*152-0185-00	Silicon	Replaceable by 1N4152	6000-up
D466	*152-0185-00	Silicon	Replaceable by 1N4152	
D469	152-0278-00	Zener	1N437A 0.4 W, 3 V, 5%	X6000-up
D470	152-0142-00	Zener	1N972A 0.4 W, 30 V, 10%	X998-3439
D470	152-0282-00	Zener	1N972B 0.4 W, 30 V, 5%	3440-up

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description	S/N Range
D471	*152-0061-00	Silicon	Tek Spec	X998-up
D472	*152-0185-00	Silicon	Replaceable by 1N4152	X998-up
D473	*152-0185-00	Silicon	Replaceable by 1N4152	X998-up
D474	*152-0061-00	Silicon	Tek Spec	
D475	*152-0061-00	Silicon	Tek Spec	
D481	*152-0185-00	Silicon	Replaceable by 1N4152	
D482	*152-0185-00	Silicon	Replaceable by 1N4152	100-5999
D482	*152-0249-00	Silicon	Assembly	6000 up
D486	*152-0185-00	Silicon	Replaceable by 1N4152	100-5999X
D545	152-0142-00	Zener	1N972A 0.4 W, 30 V, 10%	X1000-3439
D545	152-0282-00	Zener	1N972B 0.4 W, 30 V, 5%	3440-up
D554	*152-0185-00	Silicon	Replaceable by 1N4152	
D555	*152-0185-00	Silicon	Replaceable by 1N4152	X2600-up
D575	*152-0185-00	Silicon	Replaceable by 1N4152	
D610	152-0066-00	Silicon	1N3194	
D611	152-0066-00	Silicon	1N3194	
D614	152-0123-00	Zener	1N935A 0.4 W, 9.1 V, 5%	
D640A,B,C,D (4)	152-0066-00	Silicon	1N3194	
D643	*152-0185-00	Silicon	Replaceable by 1N4152	X2270-up
D649	152-0066-00	Silicon	1N3194	X2270-up
D650A,B,C,D (4)	152-0066-00	Silicon	1N3194	
D803	*152-0061-00	Silicon	Tek Spec	X6000-up
D805	*152-0170-00	Silicon	Tek Spec	X6000-up
D806	*152-0170-00	Silicon	Tek Spec	X6000-up
D810	*152-0185-00	Silicon	Replaceable by 1N4152	X6000-up
D822	152-0218-00	Silicon	10,000 V, 20 mA	X6000-up
D832	152-0218-00	Silicon	10,000 V, 20 mA	X6000-up
D847	152-0288-00	Zener	0.4 W, 140 V, 5%	X6000-up
D865	152-0287-00	Zener	1N986B 0.4 W, 110 V, 5%	X6000-up
D881	*152-0185-00	Silicon	Replaceable by 1N4152	

Fuses

F601	159-0041-00	1.25 A, 3 AG, Slo-Blo, 115 V operation
F601	159-0043-00	0.6 A, 3 AG, Slo-Blo, 230 V operation
F637	159-0031-00	0.4 A, 3 AG, Slo-Blo
F648	159-0030-00	0.3 A, 3 AG, Fast-Blo

Connectors

J101	131-0064-00	Connector, chassis mtd, Coaxial
J102	131-0064-00	Connector, chassis mtd, Coaxial
J198	131-0081-00	Connector, chassis mtd, Coaxial, 1 contact, female
J201	131-0064-00	Connector, chassis mtd, Coaxial
J202	131-0064-00	Connector, chassis mtd, Coaxial
J301	131-0081-00	Connector, chassis mtd, Coaxial, 1 contact, female
J302	131-0081-00	Connector, chassis mtd, Coaxial, 1 contact, female
J501	136-0089-00	Socket, 9 pin chassis mtd
J885	131-0081-00	Connector, chassis mtd, Coaxial, 1 contact, female
J886	131-0081-00	Connector, chassis mtd, Coaxial, 1 contact, female

Relay

K501	148-0024-00	24 V DC, 700 Ω Plug-in

Inductors

Ckt. No.	Tektronix Part No.	Description			S/N Range
L101	*108-0326-00	150 nH			X3453-up
L113	276-0507-00	Core, Ferramic Suppressor			
L133	114-0200-00	60-120 μH	Var	Core not replaceable	X6000-up
L134	114-0174-00	120-280 μH	Var	Core not replaceable	X6000-up
L135	114-0174-00	120-280 μH	Var	Core not replaceable	X6000-up
L137	*108-0109-00	60 μH			100-3809
L137	*108-0458-00	72 μH			3810-up
L138	*114-0241-00	23-64 μH	Var	Core not replaceable	X6000-up
L139	*108-0214-00	400 μH			100-5999
L139	*108-0497-00	14 μH			6000-up
L144	276-0507-00	Core, Ferramic Suppressor			X3552-up
L159	*108-0260-00	0.1 μH			
L162	*114-0194-00	58-90 μH	Var	Core 276-0511-00	
L201	*108-0326-00	150 nH			X3453-up
L213	276-0507-00	Core, Ferramic Suppressor			
L231	276-0528-00	Core, Ferramic Suppressor			X2609-up
L233	114-0200-00	60-120 μH	Var	Core not replaceable	X6000-up
L234	114-0174-00	120-280 μH	Var	Core not replaceable	X6000-up
L235	114-0174-00	120-280 μH	Var	Core not replaceable	X6000-up
L237	*108-0392-00	60 μH			100-3809
L237	*108-0461-00	72 μH			3810-up
L238	*114-0241-00	23-64 μH	Var	Core not replaceable	X6000-up
L239	*108-0393-00	400 μH			100-5999X
L244	276-0507-00	Core, Ferramic Suppressor			X3552-up
L259	*108-0260-00	0.1 μH			
L262	*114-0194-00	58-90 μH	Var	Core 276-0511-00	
L274	108-0226-00	100 μH			X6000-up
L286	276-0507-00	Core, Ferramic Suppressor			X1830-up
L655	*108-0285-00	Coil, Beam Rotator			

Transistors

Q114	*151-0108-00	Replaceable by 2N2501
Q124	*151-0154-00	Replaceable by 2N2924
Q144	*151-0133-00	Selected from 2N3251
Q154	*151-0108-00	Replaceable by 2N2501
Q164	*151-0127-00	Selected from 2N2369
Q174	151-0063-00	2N2207
Q184	151-0063-00	2N2207
Q193†	*151-0153-00	Replaceable by 2N2923
Q214	*151-0108-00	Replaceable by 2N2501
Q244	*151-0133-00	Selected from 2N3251
Q254	*151-0108-00	Replaceable by 2N2501
Q264	*151-0127-00	Selected from 2N2369
Q273	*151-0153-00	Replaceable by 2N2923
Q274	151-0063-00	2N2207
Q280	151-0107-00	2N967
Q280	151-0188-00	2N3906
Q284	151-0063-00	2N2207

†151-0154-00 and 151-0155-00 may be substituted.

Transistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q314	151-0063-00	2N2207	
Q325	*151-0133-00	Selected from 2N3251	
Q335	*151-0133-00	Selected from 2N3251	
Q344	151-0041-00	2N1303	
Q355	*151-0153-00	Replaceable by 2N2923	100-1599
Q355	151-0190-00	Silicon 2N3904	1600-up
Q365	*151-0153-00	Replaceable by 2N2923	100-1599
Q365	151-0190-00	Silicon 2N3904	1600-up
Q375	151-0041-00	2N1303	
Q385	151-0041-00	2N1303	
Q414	*151-0151-00	Replaceable by 2N930	
Q415	*151-0151-00	Replaceable by 2N930	
Q425	*151-0153-00	Replaceable by 2N2923	
Q434	151-0063-00	2N2207	
Q455	*151-0154-00	Replaceable by 2N2924	100-997
Q455	151-0190-00	Silicon 2N3904	998-up
Q465	*151-0153-00	Replaceable by 2N2923	100-997
Q465	151-0190-00	Silicon 2N3904	998-up
Q474	*151-0096-00	Selected from 2N1893	100-2739
Q474	151-0150-00	Silicon 2N3440	2740-up
Q481	*151-0103-00	Replaceable by 2N2219	
Q483	*151-0155-00	Replaceable by 2N2925	100-5999
Q483	151-1022-00	Silicon FET	6000-up
Q533	*151-0133-00	Selected from 2N3251	100-2679
Q533	151-0188-00	Silicon 2N3906	2680-up
Q544	*151-0151-00	Replaceable by 2N930	100-2599
Q544	151-0190-00	Silicon 2N3904	2600-up
Q574	151-0063-00	2N2207	
Q616	*151-0151-00	Replaceable by 2N930	
Q626	*151-0151-00	Replaceable by 2N930	
Q634	*151-0153-00	Replaceable by 2N2923	
Q637	151-0137-00	2N2148	
Q643	*151-0155-00	Replaceable by 2N2925	
Q644	*151-0134-00	Replaceable by 2N2905	
Q647	*151-0148-00	Selected from 40250 (RCA)	
Q804	*151-0136-00	Replaceable by 2N3053	
Q874	*151-0103-00	Replaceable by 2N2219	

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R101	315-0100-00	10 Ω	¼ W			5%
R104	316-0105-00	1 meg	¼ W			
R106	316-0474-00	470 k	¼ W			
R110	316-0101-00	100 Ω	¼ W			
R113	315-0682-00	6.8 k	¼ W			5%
R114	321-0227-00	2.26 k	⅛ W		Prec	1%
R115	311-0546-00	10 k		Var		
R118A	321-0247-00	3.65 k	⅛ W		Prec	1%
R118B	321-0219-00	1.87 k	⅛ W		Prec	1%
R118C	321-0167-00	536 Ω	⅛ W		Prec	1%

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R119	311-0169-00	100 Ω		Var			
R120	321-0175-00	649 Ω	1/8 W		Prec	1%	
R121	308-0334-00	7 k	3 W		WW	3%	
R122	321-0271-00	6.49 k	1/8 W		Prec	1%	100-5999
R122	321-0173-00	619 Ω	1/8 W		Prec	1%	6000-up
R123	321-0250-00	3.92 k	1/8 W		Prec	1%	
R125	321-0267-00	5.9 k	1/8 W		Prec	1%	X6000-up
R130	311-0224-00	50 k		Var			
R131	315-0823-00	82 k	1/4 W			5%	
R135	321-0279-00	7.87 k	1/8 W		Prec	1%	100-5999X
R138	315-0470-00	47 Ω	1/4 W			5%	X6000-up
R141	321-0131-00	226 Ω	1/8 W		Prec	1%	100-2068
R141	321-0121-00	178 Ω	1/8 W		Prec	1%	2069-up
R143	305-0153-00	15 k	2 W			5%	
R144	321-0297-00	12.1 k	1/8 W		Prec	1%	
R148	301-0333-00	33 k	1/2 W			5%	
R149	315-0392-00	3.9 k	1/4 W			5%	
R154	321-0213-00	1.62 k	1/8 W		Prec	1%	
R160	308-0017-00	2 k	10 W		WW	5%	100-5999
R160	308-0055-00	1.5 k	10 W		WW	5%	6000-up
R161	308-0241-00	22 k	7 W		WW	1%	X6000-up
R162	*310-0621-00	3 k	8 W		Prec	1%	
R163	315-0104-00	100 k	1/4 W			5%	
R164	316-0470-00	47 Ω	1/4 W				
R165	316-0101-00	100 Ω	1/4 W				X6000-up
R166	308-0077-00	1 k	3 W		WW		
R167	321-0335-00	30.1 k	1/8 W		Prec	1%	
R168	315-0750-00	75 Ω	1/4 W			5%	
R169	311-0003-00	100 Ω		Var			
R172	315-0112-00	1.1 k	1/4 W			5%	
R173	304-0273-00	27 k	1 W				
R183	315-0271-00	270 Ω	1/4 W			5%	
R184	315-0103-00	10 k	1/4 W			5%	
R192	316-0222-00	2.2 k	1/4 W				100-1369
R192	315-0242-00	2.4 k	1/4 W			5%	1370-up
R193	316-0122-00	1.2 k	1/4 W				100-1369
R193	304-0122-00	1.2 k	1 W				1370-up
R197	316-0102-00	1 k	1/4 W				
R198	301-0750-00	75 Ω	1/2 W			5%	
R199	316-0103-00	10 k	1/4 W				
R201	315-0100-00	10 Ω	1/4 W			5%	
R204	316-0105-00	1 meg	1/4 W				
R206	316-0474-00	470 k	1/4 W				
R210	316-0101-00	100 Ω	1/4 W				
R213	315-0682-00	6.8 k	1/4 W			5%	
R214	321-0227-00	2.26 k	1/8 W		Prec	1%	
R220	321-0175-00	649 Ω	1/8 W		Prec	1%	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R231	315-0823-00	82 k	1/4 W			5%	
R238	315-0470-00	47 Ω	1/4 W			5%	X6000-up
R240†	311-0506-00	500 Ω		Var			
R241	321-0121-00	178 Ω	1/8 W		Prec	1%	100-2068
R241	321-0131-00	226 Ω	1/8 W		Prec	1%	2069-up
R242	316-0224-00	220 k	1/4 W				
R243	305-0153-00	15 k	2 W			5%	
R244	321-0297-00	12.1 k	1/8 W		Prec	1%	
R245	311-0016-00	10 k		Var			
R248	301-0333-00	33 k	1/2 W			5%	
R249	315-0392-00	3.9 k	1/4 W			5%	
R254	321-0213-00	1.62 k	1/8 W		Prec	1%	
R262	*310-0621-00	3 k	8 W		Prec	1%	
R263	315-0104-00	100 k	1/4 W			5%	
R264	316-0470-00	47 Ω	1/4 W				
R265	316-0101-00	100 Ω	1/4 W				X6000-up
R266	308-0077-00	1 k	3 W		WW		
R267	316-0271-00	270 Ω	1/4 W				
R268	315-0750-00	75 Ω	1/4 W			5%	
R274	315-0153-00	15 k	1/4 W			5%	
R275	315-0752-00	7.5 k	1/4 W			5%	
R276	315-0104-00	100 k	1/4 W			5%	
R280	315-0183-00	18 k	1/4 W			5%	100-5999
R280	321-0300-00	13 k	1/8 W		Prec	1%	6000-up
R281	315-0682-00	6.8 k	1/4 W			5%	100-5999
R281	321-0273-00	6.81 k	1/8 W		Prec	1%	6000-up
R282	315-0105-00	1 meg	1/4 W			5%	
R283	316-0151-00	150 Ω	1/4 W				100-5999X
R284	316-0150-00	15 Ω	1/4 W				100-5999
R284	315-0150-00	15 Ω	1/4 W			5%	6000-up
R285	321-0385-00	100 k	1/8 W		Prec	1%	
R286	321-0385-00	100 k	1/8 W		Prec	1%	
R287	321-0328-00	25.5 k	1/8 W		Prec	1%	
R288	321-0328-00	25.5 k	1/8 W		Prec	1%	
R289	316-0333-00	33 k	1/4 W				
R290	315-0472-00	4.7 k	1/4 W			5%	
R291	315-0153-00	15 k	1/4 W			5%	X6094-up
R292	316-0224-00	220 k	1/4 W				
R293	316-0224-00	220 k	1/4 W				
R296	316-0101-00	100 Ω	1/4 W				
R297	315-0103-00	10 k	1/4 W			5%	
R298	315-0472-00	4.7 k	1/4 W			5%	
R299	315-0104-00	100 k	1/4 W			5%	
R301	301-0564-00	560 Ω	1/2 W			5%	
R302	315-0392-00	3.9 k	1/4 W			5%	X1830-up
R303	315-0223-00	22 k	1/4 W			5%	X1830-up
R304	315-0155-00	1.5 meg	1/4 W			5%	

†Furnished as a unit with SW240.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R305	315-0103-00	10 k	¼ W			5%	
R310	316-0101-00	100 Ω	¼ W				
R312	315-0104-00	100 k	¼ W			5%	X1830-up
R313	315-0153-00	15 k	¼ W			5%	
R314	315-0153-00	15 k	¼ W			5%	100-1829
R314	316-0682-00	6.8 k	¼ W				1830-up
R315	316-0223-00	22 k	¼ W				100-1829
R315	315-0333-00	33 k	¼ W			5%	1830-up
R317	316-0106-00	10 meg	¼ W				100-1829
R317	302-0156-00	15 meg	½ W				1830-up
R318	316-0106-00	10 meg	¼ W				100-1829
R318	316-0103-00	10 k	¼ W				1830-up
R319	316-0225-00	2.2 meg	¼ W				100-212
R319	316-0335-00	3.3 meg	¼ W				213-up
R323	323-0346-00	39.2 k	½ W		Prec	1%	
R324	321-0218-00	1.82 k	⅛ W		Prec	1%	
R325	311-0369-00	100 k		Var			
R326	323-0414-00	200 k	½ W		Prec	1%	
R327	321-0297-00	12.1 k	⅛ W		Prec	1%	
R328	321-0387-00	105 k	⅛ W		Prec	1%	
R329	315-0333-00	33 k	¼ W			5%	X1830-up
R333	323-0346-00	39.2 k	½ W		Prec	1%	
R334	302-0182-00	1.8 k	½ W				
R335	321-0201-00	1.21 k	⅛ W		Prec	1%	100-1829
R335	321-0189-00	909 Ω	⅛ W		Prec	1%	1830-up
R336	315-0331-00	330 Ω	¼ W			5%	X1830-up
R341	315-0682-00	6.8 k	¼ W			5%	
R342	315-0272-00	2.7 k	¼ W			5%	
R343	315-0183-00	18 k	¼ W			5%	
R344	315-0392-00	3.9 k	¼ W			5%	
R346	316-0226-00	22 meg	¼ W				
R347	315-0103-00	10 k	¼ W			5%	
R351	315-0103-00	10 k	¼ W			5%	100-1599
R351	321-0289-00	10 k	⅛ W		Prec	1%	1600-up
R352	321-0397-00	133 k	⅛ W		Prec	1%	X1600-up
R354	315-0683-00	68 k	¼ W			5%	
R355	315-0103-00	10 k	¼ W			5%	100-1599
R355	321-0289-00	10 k	⅛ W		Prec	1%	1600-up
R358	315-0243-00	24 k	¼ W			5%	100-1599
R358	321-0327-00	24.9 k	⅛ W		Prec	1%	1600-up
R360	311-0183-00	500 k		Var			
R361	316-0394-00	390 k	¼ W				100-1599
R361	323-0612-00	950 k	½ W		Prec	1%	1600-up
R362	301-0245-00	2.4 meg	½ W			5%	X1600-up
R363	315-0223-00	22 k	¼ W			5%	X1600-up
R364	315-0683-00	68 k	¼ W			5%	
R365	315-0103-00	10 k	¼ W			5%	100-1599
R365	321-0333-00	28.7 k	⅛ W		Prec	1%	1600-up

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R368	Use 323-0493-00	1.33 meg	1/2 W		1%	100-1599
R368	321-0452-00	499 k	1/8 W	Prec	1%	1600-up
R369	315-0103-00	10 k	1/4 W		5%	100-1599
R369	301-0333-00	33 k	1/2 W		5%	1600-up
R371	316-0336-00	33 meg	1/4 W			
R372	315-0472-00	4.7 k	1/4 W		5%	
R373	316-0105-00	1 meg	1/4 W			X1600-up
R374	315-0103-00	10 k	1/4 W		5%	
R375	316-0473-00	47 k	1/4 W			
R376	316-0182-00	1.8 k	1/4 W			
R377	316-0473-00	47 k	1/4 W			
R378	316-0105-00	1 meg	1/4 W			
R383	316-0105-00	1 meg	1/4 W			X1600-up
R384	315-0103-00	10 k	1/4 W		5%	
R385	316-0473-00	47 k	1/4 W			
R386	316-0182-00	1.8 k	1/4 W			
R387	316-0473-00	47 k	1/4 W			
R388	316-0105-00	1 meg	1/4 W			
R401	316-0471-00	470 Ω	1/4 W			
R402	323-0308-00	15.8 k	1/2 W	Prec	1%	
R405	311-0360-00	5 k		Var		100-997
R405	311-0360-01	5 k		Var		998-up
R409	315-0472-00	4.7 k	1/4 W		5%	X1830-up
R411	316-0102-00	1 k	1/4 W			
R412	315-0104-00	100 k	1/4 W		5%	
R413	315-0105-00	1 meg	1/4 W		5%	
R414	315-0472-00	4.7 k	1/4 W		5%	
R416	321-0452-00	499 k	1/8 W	Prec	1%	
R417	323-0352-00	45.3 k	1/2 W	Prec	1%	
R418	323-0304-00	14.3 k	1/2 W	Prec	1%	100-1244
R418	323-0304-00	14.3 k	1/2 W	Selected (nominal value)	1%	1245-up
R419	Use 323-0442-00	392 k	1/2 W	Selected (nominal value)	1%	
R421	315-0154-00	150 k	1/4 W		5%	
R422	316-0123-00	12 k	1/4 W			
R423	315-0154-00	150 k	1/4 W		5%	
R426	315-0563-00	56 k	1/4 W		5%	X1600-up
R431	315-0223-00	22 k	1/4 W		5%	
R432	316-0823-00	82 k	1/4 W			
R439	316-0101-00	100 Ω	1/4 W			
R441	315-0103-00	10 k	1/4 W		5%	
R442	315-0104-00	100 k	1/4 W		5%	
R445	302-0333-00	33 k	1/2 W			X998-up
R446	315-0104-00	100 k	1/4 W		5%	
R447	315-0393-00	39 k	1/4 W		5%	
R448	316-0104-00	100 k	1/4 W			X998-up
R449	316-0104-00	100 k	1/4 W			X998-up
R450	315-0104-00	100 k	1/4 W		5%	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R451	315-0223-00	22 k	¼ W		5%	
R452	315-0223-00	22 k	¼ W		5%	
R453	303-0303-00	30 k	1W		5%	100-5999
R453	303-0273-00	27 k	1 W		5%	6000-up
R454	315-0623-00	62 k	¼ W		5%	100-997
R454	315-0623-00	62 k	¼ W	Selected (nominal value)	5%	998-1099
R454	315-0563-00	56 k	¼ W	Selected (nominal value)	5%	1100-up
R455	315-0472-00	4.7 k	¼ W		5%	100-997
R455	321-0258-00	4.75 k	⅛ W	Prec	1%	998-up
R456	323-0320-00	21 k	½ W	Prec	1%	100-997
R456	321-0317-00	19.6 k	⅛ W	Prec	1%	998-up
R457	323-0393-00	121 k	½ W	Selected (nominal value)	1%	X998-up
R458	311-0026-00	100 k		Var		X998-up
R460	315-0472-00	4.7 k	¼ W		5%	X1830-up
R461	315-0393-00	39 k	¼ W		5%	100-997X
R461A	321-0341-00	34.8 k	⅛ W	Prec	1%	X998-up
R461B	321-0239-00	3.01 k	⅛ W	Prec	1%	X998-up
R461C	321-0239-00	3.01 k	⅛ W	Prec	1%	X998-up
R461D	321-0239-00	3.01 k	⅛ W	Prec	1%	X998-up
R461E	321-0239-00	3.01 k	⅛ W	Prec	1%	X998-up
R461F	321-0239-00	3.01 k	⅛ W	Prec	1%	X998-up
R461G	321-0210-00	1.5 k	⅛ W	Prec	1%	X998-up
R462	315-0272-00	2.7 k	¼ W		5%	X998-up
R464	301-0433-00	43 k	½ W		5%	
R465	315-0113-00	11 k	¼ W		5%	
R466	321-0335-00	30.1 k	⅛ W	Prec	1%	
R467	315-0512-00	5.1 k	¼ W		5%	X3916-up
R468	301-0154-00	150 k	½ W		5%	100-1599
R468	301-0104-00	100 k	½ W		5%	1600-2213
R468	323-0401-00	147 k	½ W	Prec	1%	2214-3915
R468	323-0394-00	124 k	½ W	Prec	1%	3916-5999
R468	323-0335-00	30.1 k	½ W	Prec	1%	6000-up
R469	301-0473-00	47 k	½ W		5%	
R470	315-0113-00	11 k	¼ W		5%	
R471	316-0563-00	56 k	¼ W			100-997X
R472	Use 316-0334-00	330 k	¼ W			X998-up
R473	316-0563-00	56 k	¼ W			X998-up
R474	*310-0614-00	41.5 k	8 W	Prec	1%	100-3229
R474	308-0168-01	40 k	8 W	WW	1%	3230-up
R475	315-0105-00	1 meg	¼ W		5%	
R476	315-0393-00	39 k	¼ W		5%	
R477	302-0273-00	27 k	½ W			
R478	315-0103-00	10 k	¼ W		5%	100-2929
R478	315-0183-00	18 k	¼ W		5%	2930-5999
R478	315-0223-00	22 k	¼ W		5%	6000-up
R480	321-0289-00	10 k	⅛ W	Prec	1%	X6000-up
R481	321-0409-00	178 k	⅛ W	Prec	1%	100-5999

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R481	321-0404-00	158 k	1/8 W	Prec	1%	6000-up
R482	321-0350-00	43.2 k	1/8 W	Prec	1%	100-5999
R482	321-0345-00	38.3 k	1/8 W	Prec	1%	6000-up
R483	321-0397-00	133 k	1/8 W	Prec	1%	100-5999
R483	321-0392-00	118 k	1/8 W	Prec	1%	6000-up
R484	321-0379-00	86.6 k	1/8 W	Prec	1%	100-5999
R484	321-0375-00	78.7 k	1/8 W	Prec	1%	6000-up
R486	316-0475-00	4.7 meg	1/4 W			100-999
R486	316-0334-00	330 k	1/4 W			1000-5999
R486	315-0822-00	8.2 k	1/4 W		5%	6000-up
R487	316-0224-00	220 k	1/4 W			100-5999
R487	301-0203-00	20 k	1/2 W		5%	6000-up
R488	315-0103-00	10 k	1/4 W		5%	
R489	304-0183-00	18 k	1 W			
R491	301-0752-00	7.5 k	1/2 W		5%	
R492	321-0331-00	27.4 k	1/8 W	Prec	5%	100-997
R492	321-0329-00	26.1 k	1/8 W	Prec	1%	998-5999
R492	321-0328-00	25.5 k	1/8 W	Prec	1%	6000-up
R493	323-0346-00	39.2 k	1/2 W	Prec	1%	X998-up
R501	323-0496-00	1.43 meg	1/2 W	Prec	1%	
R502	321-0450-00	475 k	1/8 W	Prec	1%	
R504	323-0468-00	732 k	1/2 W	Prec	1%	
R509	323-0481-00	1 meg	1/2 W	Prec	1%	
R510	316-0101-00	100 Ω	1/4 W			
R514	302-0223-00	22 k	1/2 W			
R516	321-0368-00	66.5 k	1/8 W	Prec	1%	
R517	321-0351-00	44.2 k	1/8 W	Prec	1%	
R520	323-0377-00	82.5 k	1/2 W	Prec	1%	
R521	321-0386-00	102 k	1/8 W	Prec	1%	
R522	321-0317-00	19.6 k	1/8 W	Prec	1%	100-3399
R522	321-0318-00	20 k	1/8 W	Prec	1%	3400-up
R523	321-0249-00	3.83 k	1/8 W	Prec	1%	
R525	323-0373-00	75 k	1/2 W	Prec	1%	
R526	311-0360-00	5 k	Var			
R533	316-0224-00	220 k	1/4 W			
R534	315-0222-00	2.2 k	1/4 W		5%	
R535	315-0273-00	27 k	1/4 W		5%	
R544	315-0104-00	100 k	1/4 W		5%	
R545	315-0474-00	470 k	1/4 W		5%	100-999
R545	316-0102-00	1 k	1/4 W			1000-up
R546	302-0274-00	270 k	1/2 W			
R551	316-0101-00	100 Ω	1/4 W			
R554	*310-0614-00	41.5 k	8 W	Prec	1%	100-3229
R554	308-0168-01	40 k	8 W	WW	1%	3230-up
R556	321-0269-00	6.19 k	1/8 W	Prec	1%	
R558	Use 322-0123-00	187 Ω	1/4 W	Prec	1%	100-5999
R558	322-0648-00	133 Ω	1/4 W	Prec	1/2%	6000-up
R561	316-0101-00	100 Ω	1/4 W			

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R564	*310-0614-00	41.5 k	8 W		Prec	1%	100-3229
R564	308-0168-01	40 k	8 W		WW	1%	3230-up
R566	321-0269-00	6.19 k	1/8 W		Prec	1%	
R568	311-0178-00	200 Ω		Var			100-6093
R568	311-0004-00	200 Ω		Var			6094-up
R573	301-0473-00	47 k	1/2 W			5%	
R574	315-0273-00	27 k	1/4 W			5%	
R575	311-0178-00	200 Ω		Var			
R576	315-0392-00	3.9 k	1/4 W			5%	
R601†	311-0057-00	50 Ω		Var			
R614	315-0242-00	2.4 k	1/4 W			5%	
R616	315-0184-00	180 Ω	1/4 W			5%	
R617	316-0471-00	470 Ω	1/4 W				
R618	315-0183-00	18 k	1/4 W			5%	
R620	311-0147-00	10 k		Var			
R621	302-0122-00	1.2 k	1/2 W				
R624	321-0206-00	1.37 k	1/8 W		Prec	1%	
R625	315-0103-00	10 k	1/4 W			5%	
R626	321-0233-00	2.61 k	1/8 W		Prec	1%	
R634	304-0223-00	22 k	1 W				
R637	302-0102-00	1 k	1/2 W				
R640	307-0007-00	2.7 Ω	1 W				
R641	323-0335-00	30.1 k	1/2 W		Prec	1%	
R642	321-0277-00	7.5 k	1/8 W		Prec	1%	
R643	315-0104-00	100 k	1/4 W			5%	
R644	316-0102-00	1 k	1/4 W				
R645	302-0103-00	10 k	1/2 W				100-3229
R645	308-0212-00	10 k	3 W		WW	5%	3230-up
R646	301-0221-00	220 Ω	1/2 W			5%	
R647	304-0120-00	12 Ω	1 W				
R648	302-0103-00	10 k	1/2 W				100-3229X
R649	316-0221-00	220 Ω	1/4 W				X2270-up
R650	307-0009-00	4.7 Ω	1 W				
R655	311-0317-00	2 x 1 k		Var			
R656	302-0102-00	1 k	1/2 W				
R800	302-0101-00	100 Ω	1/2 W				
R801	301-0100-00	10 Ω	1/2 W			5%	100-5999X
R802	316-0101-00	100 Ω	1/4 W				
R803	308-0168-01	40 k	8 W		WW	5%	X6000-up
R806	323-0471-01	787 k	1/2 W		Prec	1/2%	X6000-up
R808	302-0102-00	1 k	1/2 W				X6000-up
R809	315-0105-00	1 meg	1/4 W			5%	
R810	316-0101-00	100 Ω	1/4 W				
R814	311-0184-00	1 meg		Var			100-5999
R814	311-0252-00	1 meg		Var			6000-up
R815	316-0335-00	3.3 meg	1/4 W				100-5999X

†Furnished as a unit with SW601.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R816	321-1485-00	1.11 meg	1/8 W		Prec	1%	X6000-up
R818	315-0273-00	27 k	1/4 W			5%	X6000-up
R819	321-0414-00	200 k	1/8 W		Prec	1%	X6000-up
R821	321-0249-00	3.83 k	1/8 W		Prec	1%	X6000-up
R832	302-0104-00	100 k	1/2 W				X6000-up
R833	306-0106-00	10 meg	2 W				X6000-up
R834	315-0105-00	1 meg	1/4 W			5%	100-5999X
R835	311-0183-00	500 k		Var			100-5999X
R836	316-0475-00	4.7 meg	1/4 W				100-5999X
R837	305-0565-00	5.6 meg	2 W			5%	100-5999
R837	305-0685-00	6.8 meg	2 W			5%	6000-up
R838	305-0685-00	6.8 meg	2 W			5%	
R839	305-0565-00	5.6 meg	2 W			5%	100-5999
R839	305-0685-00	6.8 meg	2 W			5%	6000-up
R841	305-0685-00	6.8 meg	2 W			5%	100-5999
R841	305-0565-00	5.6 meg	2 W			5%	6000-up
R842	305-0565-00	5.6 meg	2 W			5%	
R843	305-0685-00	6.8 meg	2 W			5%	100-5999
R843	305-0565-00	5.6 meg	2 W			5%	6000-up
R844	311-0505-00	10 meg		Var			100-3529
R844	311-0505-01	10 meg		Var			3530-up
R845	305-0685-00	6.8 meg	2 W			5%	
R846	Use 311-0314-00	2 meg		Var			100-3529
R846	311-0314-01	2 meg		Var			3530-up
R847	315-0184-00	180 k	1/4 W			5%	100-2929
R847	315-0124-00	120 k	1/4 W			5%	2930-5999
R847	302-0824-00	820 k	1/2 W				6000-up
R848	315-0155-00	1.5 meg	1/4 W			5%	100-5999
R848	311-0174-00	3.5 meg		Var			6000-up
R849	301-0155-00	1.5 meg	1/2 W			5%	
R850	301-0102-00	1 k	1/2 W			5%	X6000-up
R851	316-0104-00	100 k	1/4 W				X6000-up
R855	311-0183-00	500 k		Var			X2440-up
R856	315-0114-00	110 k	1/4 W			5%	X2440-up
R857	315-0223-00	22 k	1/4 W			5%	X2440-up
R864	311-0184-00	1 meg		Var			
R865	316-0184-00	180 k	1/4 W				
R866	301-0684-00	680 k	1/2 W			5%	100-5999
R866	316-0105-00	1 meg	1/4 W				6000-up
R874	304-0273-00	27 k	1 W				
R875	315-0393-00	39 k	1/4 W			5%	
R876	316-0152-00	1.5 k	1/4 W				
R881	321-0327-00	24.9 k	1/8 W		Prec	1%	
R882	321-0146-00	324 Ω	1/8 W		Prec	1%	
R883	321-0191-00	953 Ω	1/8 W		Prec	1%	
R885	321-0141-00	287 Ω	1/8 W		Prec	1%	
R886	321-0179-00	715 Ω	1/8 W		Prec	1%	

Switches

Ckt. No.	Tektronix Part No. Unwired	Wired	Description		S/N Range
SW101	260-0658-00	*262-0756-00	Rotary	INPUT	
SW118	260-0654-00	*262-0753-00	Rotary	VOLTS FULL SCALE	100-2068
SW118	260-0654-00	*262-0753-01	Rotary	VOLTS FULL SCALE	2069-5999
SW118	260-0654-00	*262-0753-02	Rotary	VOLTS FULL SCALE	6000-up
SW135	260-0655-01	*262-0757-00	Rotary	RESPONSE	100-5999
SW135	260-1000-00	*262-0757-01	Rotary	RESPONSE	6000-up
SW240†	311-0506-00			VARIABLE	
SW290	260-0716-00		Toggle	DC RESTORER	100-2769
SW290	260-0716-01		Toggle	DC RESTORER	2770-up
SW305	260-0473-00		Lever	SYNC	
SW380	Use 260-0800-00		Toggle	FIELD	
SW430	260-0657-00	*262-0755-00	Rotary	DISPLAY	100-997
SW430	260-0657-00	*262-0755-01	Rotary	DISPLAY	998-5999
SW430	260-0657-01	*262-0755-02	Rotary	DISPLAY	6000-up
SW461	260-0793-00	*262-0773-01	Rotary	LINE SELECTOR	X998-up
SW520	260-0656-00	*262-0754-00	Rotary	MAG	100-999
SW520	260-0656-00	*262-0754-01	Rotary	MAG	1000-2639
SW520	260-0656-01	*262-0754-02	Rotary	MAG	2640-up
SW601††	311-0057-00			POWER	
SW885	260-0490-00		Lever	CALIBRATOR	

Transformers

T135	120-0362-00	RF 3.58 MHz	Center Frequency	100-5999X
T280	*120-0365-00	Toroid, 4 windings		100-5999
T280	*120-0574-00	Toroid, 4 windings		6000-up
T601	*120-0363-00	LV Power		
T801	*120-0364-00	HV Power		100-5999
T801	*120-0572-00	HV Power		6000-up

Electron Tubes

V113	154-0039-00	12AT7		100-2109
V113	*157-0010-00	12AT7	Checked	2110-up
V164	154-0420-00	7788		
V264	154-0420-00	7788		
V293	154-0039-00	12AT7		

†Furnished as a unit with R240.

††Furnished as a unit with R601.

Electron Tubes *(Cont'd)*

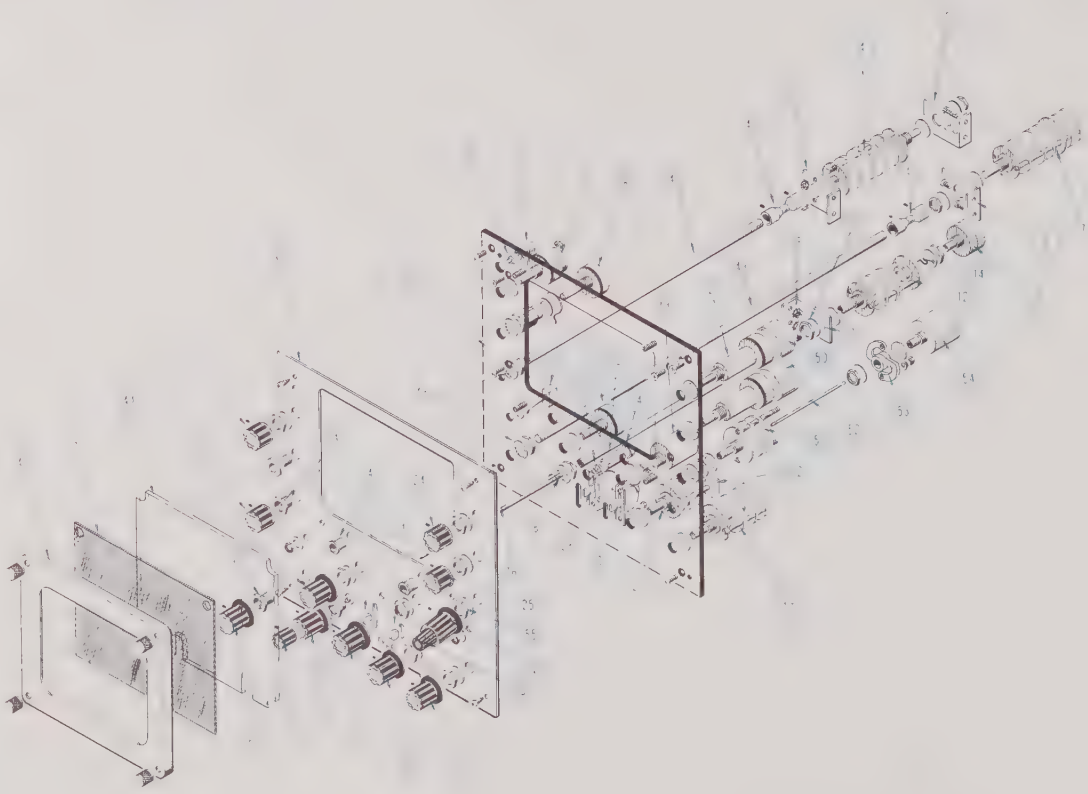
Ckt. No.	Tektronix Part No.		Description	S/N Range
V514	154-0022-03	6AU6		100-1289
V514	154-0022-00	6AU6		1290-up
V554	154-0187-00	6DJ8		
V800	154-0468-00	6GV8		
V822	154-0051-00	5642		100-5999X
V832	154-0051-00	5642		100-5999X
V859	*154-0473-00	T5290-31	Crt Standard Phosphor	100-2439
V859	*154-0507-00	T5290-31	Crt Standard Phosphor	2440-2929
V859	*154-0514-00	T5291-31	Crt Standard Phosphor	2930-up

SECTION 8

MECHANICAL PARTS LIST

A list of abbreviations and special symbols in use throughout this manual will be found immediately preceding the Electrical Parts List, Section 7. Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Parts ordering information is also located immediately preceding Section 7.

FRONT



FRONT

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	366-0148-00	100	3789	1	KNOB, charcoal—POWER and SCALE ILLUM
	366-0322-01	3790		1	KNOB, charcoal—POWER and SCALE ILLUM
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
2	- - - - - -			4	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
	210-0012-00			1	LOCKWASHER, pot, internal, 3/8 x 1/2 inch
	210-0840-00			1	WASHER, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
3	366-0148-00			1	KNOB, charcoal—RESPONSE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
4	262-0757-00			1	SWITCH, wired—RESPONSE
	- - - - - -			-	switch includes:
	260-0655-01			1	SWITCH, unwired
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, pot, internal, 3/8 x 1/2 inch
	210-0840-00			1	WASHER, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
5	407-0200-00			2	BRACKET, switch
	- - - - - -			-	mounting hardware for each: (not included w/bracket)
	211-0504-00			2	SCREW, 6-32 x 1/4 inch, PHS
6	366-0173-00	100	3789	1	KNOB, charcoal—INPUT
	366-0322-01	3790		1	KNOB, charcoal—INPUT
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
7	262-0756-00			1	SWITCH, wired—INPUT
	- - - - - -			-	switch includes:
	260-0658-00			1	SWITCH, unwired—INPUT
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, pot, internal, 3/8 x 1/2 inch
	210-0840-00			1	WASHER, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch

FRONT *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
8	407-0196-00			1	BRACKET, switch
	- - - - - -			-	mounting hardware: (not included with bracket)
	211-0504-00			2	SCREW, 6-32 x 1/4 inch, PHS
9	366-0173-00			2	KNOB, charcoal—POSITION
	- - - - - -			-	each knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
10	366-0153-00			1	KNOB, charcoal—VARIABLE
	- - - - - -			-	knob includes:
	213-0020-00			1	SCREW, set, 6-32 x 1/8 inch, HSS
11	366-0175-00	100	3789	1	KNOB, charcoal—VOLTS FULL SCALE
	366-0322-00	3790		1	KNOB, charcoal—VOLTS FULL SCALE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
12	262-0753-00	100	2068	1	SWITCH, wired—VOLTS FULL SCALE
	262-0753-01	2069		1	SWITCH, wired—VOLTS FULL SCALE
	- - - - - -			-	switch includes:
	260-0654-00			1	SWITCH, unwired—VOLTS FULL SCALE
	- - - - - -			-	mounting hardware: (not included w/switch)
13	210-0012-00			1	LOCKWASHER, pot, internal, 3/8 x 1/2 inch
	210-0840-00			1	WASHER, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
14	376-0014-00			1	COUPLING, wire
15	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0012-00			1	LOCKWASHER, pot, internal, 3/8 x 1/2 inch
	210-0413-00			2	NUT, hex., 3/8-32 x 1/2 inch
16	384-0260-00			1	ROD, extension, 1/8 inch diameter x 9 3/8 inches long
17	407-0197-00			1	BRACKET, switch
	- - - - - -			-	mounting hardware: (not included w/switch)
18	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS (not shown)
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
	210-0840-00			1	WASHER, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
	358-0029-00			1	BUSHING, hex., 3/8-32 x 13/32 inch

FRONT *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
19	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0051-00			1	LOCKWASHER, internal, 0.422 ID x 0.609 inch OD
20	366-0173-00	100	3789	1	KNOB, charcoal—MAG
	366-0322-01	3790		1	KNOB, charcoal—MAG
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
21	262-0754-00	100	999	1	SWITCH, wired—MAG
	262-0754-01	1000	2639	1	SWITCH, wired—MAG
	262-0754-02	2640		1	SWITCH, wired—MAG
	- - - - - -			-	switch includes:
	260-0656-00	100	2639	1	SWITCH, unwired
	260-0656-01	2640		1	SWITCH, unwired
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, pot, internal, 3/8 x 1/2 inch
	210-0840-00			1	WASHER, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
22	366-0173-00	100	3789	1	KNOB, charcoal—DISPLAY
	366-0322-01	3790		1	KNOB, charcoal—DISPLAY
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
23	262-0755-00	100	997	1	SWITCH, wired—DISPLAY
	262-0755-01	998		1	SWITCH, wired—DISPLAY
	- - - - - -			-	switch includes:
	260-0657-00			1	SWITCH, unwired
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0013-00			1	LOCKWASHER, pot, internal, 3/8 x 11/16 inch
	210-0840-00			1	WASHER, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
24	366-0148-00			1	KNOB, charcoal—FOCUS
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
25	366-0148-00			1	KNOB, charcoal—INTENSITY
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
26	366-0148-00	100	997	1	KNOB, charcoal—LINE SELECTOR
	366-0175-00	998	3789	1	KNOB, charcoal—LINE SELECTOR
	366-0322-00	3790		1	KNOB, charcoal—LINE SELECTOR
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS

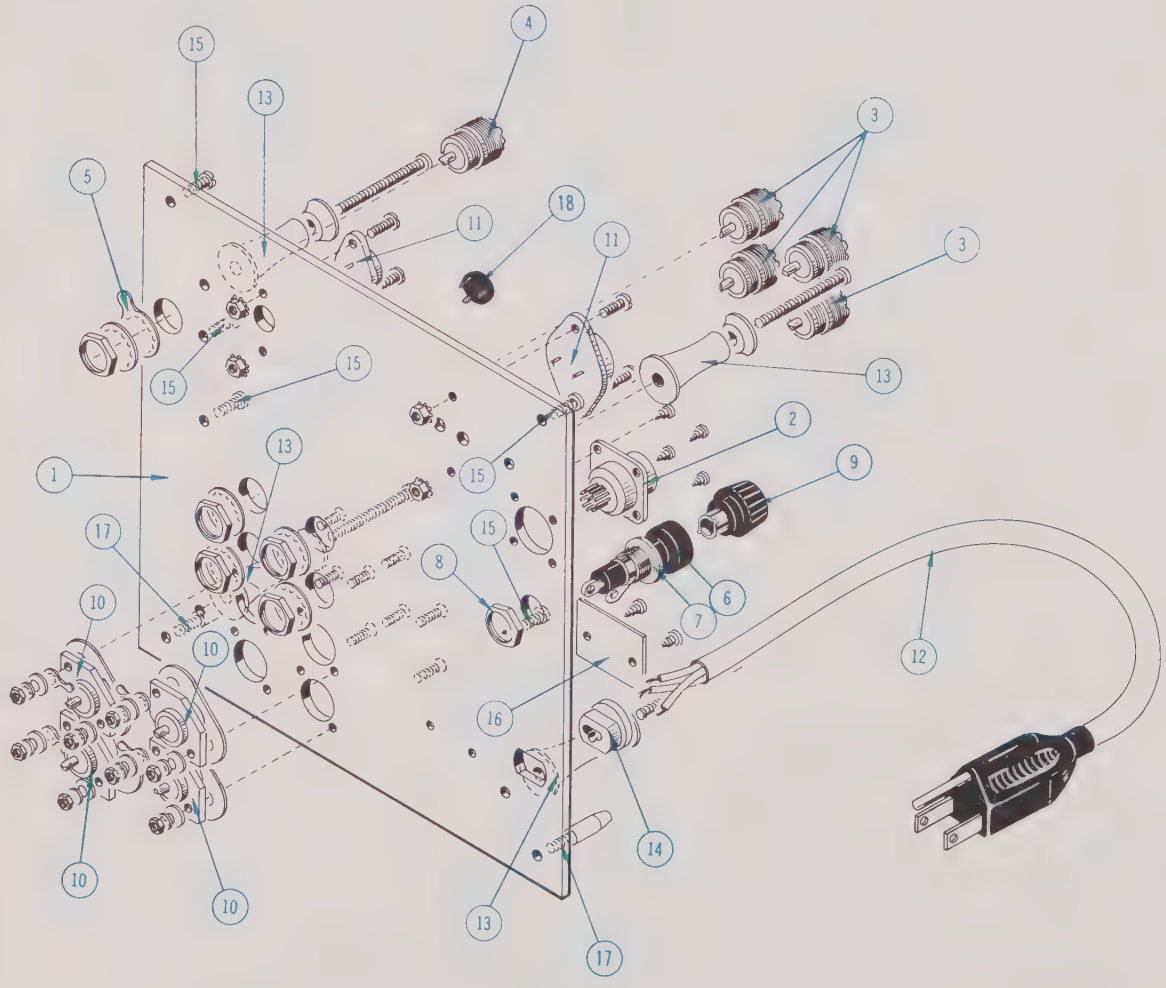
FRONT *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
27	366-0215-01			1	KNOB, charcoal—CAL
28	260-0490-00			1	SWITCH, unwired—CAL
	- - - - - -			-	mounting hardware: (not included w/switch)
	220-0413-00			2	NUT, switch mounting, w/4-40 threads
29	366-0215-01			1	KNOB, charcoal—SYNC
30	260-0473-00			1	SWITCH, unwired—SYNC
	- - - - - -			-	mounting hardware: (not included w/switch)
	220-0413-00			2	NUT, switch mounting, w/4-40 threads
31	260-0716-00	100	2769	1	SWITCH, toggle—DC RESTORER
	260-0716-01	2770		1	SWITCH, toggle—DC RESTORER
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0046-00			1	LOCKWASHER, 0.261 ID x 0.400 inch OD
	210-0940-00			1	WASHER, 1/4 ID x 3/8 inch OD
	210-0562-00			2	NUT, hex., 1/4-40 x 5/16 inch
32	260-0716-00	100	997	1	SWITCH, unwired—FIELD
	260-0800-00	998		1	SWITCH, unwired—FIELD
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0046-00	100	997	1	LOCKWASHER, 0.261 ID x 0.400 inch OD
	210-0223-00	998		1	LUG, solder, 1/4 ID x 7/16 inch OD, SE
	210-0940-00			1	WASHER, 1/4 ID x 3/8 inch OD
	210-0562-00			2	NUT, hex., 1/4-40 x 5/16 inch
33	366-0153-00	X998		1	KNOB, charcoal—VARIABLE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
34	200-0609-00			1	CAP, neon holder
35	352-0084-00			1	HOLDER, neon
36	378-0541-00			2	FILTER, lens, neon
37	352-0067-00			1	HOLDER, single
	- - - - - -			-	mounting hardware (not included w/holder)
	211-0109-00			1	SCREW, 4-40 x 7/8 inch, 100° CSK, FHS, phillips
	210-0406-00			1	NUT, hex., 4-40 x 3/16 inch

FRONT *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
38	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0207-00			1	LUG, solder, pot, plain, 3/8 inch
	210-0012-00			2	LOCKWASHER, pot, internal, 3/8 x 1/2 inch
	210-0494-00			1	NUT, hex., aluminum, 3/8-32 x 1/2 x 11/16 inch h
	358-0010-00			1	BUSHING, aluminum, 3/8-32 x 9/16 inch
39	386-0242-00			1	PLATE, sub-panel, front
40	- - - - - -			2	INSERT, graticule light (see standard accessories)
41	376-0011-00			2	COUPLING, insulating, nylon assembly
	- - - - - -			-	each coupling includes:
	213-0048-00			2	SCREW, set, 4-40 x 1/8 inch, HSS
42	384-0395-00			1	SHAFT, extension
43	384-0399-00			1	ROD, extension, shaft
44	- - - - - -			-	GRATICULE (see accesssories page)
45	- - - - - -			-	FILTER, light (see accessories page)
46	200-0272-00			1	COVER, graticule
	- - - - - -			-	mounting hardware: (not included w/cover)
	210-0434-00			4	NUT, knurled, graticule
47	358-0029-00			2	BUSHING, hex., 3/8-32 x 12/32 inch
	- - - - - -			-	mounting hardware for each: (not included w/bushing)
	210-0840-00			1	WASHER, 0.390 ID x 9/16 inch OD
48	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
49	333-0913-00	100	997	1	PANEL, front
	333-0913-01	998	3789	1	PANEL, front
	333-0913-02	3790		1	PANEL, front
	- - - - - -			-	mounting hardware: (not included w/panel)
	213-0088-00			4	SCREW, thread forming, #4 x 1/4 inch, PHS
50	200-0269-00	100	3529	2	COVER, plastic
	200-0745-00	3530		2	COVER, plastic
51	262-0773-01	X998		1	SWITCH, wired—LINE SELECTOR
	- - - - - -			-	switch includes:
	260-0793-00			1	SWITCH, unwired—LINE SELECTOR
52	384-0408-00			1	ROD, extension
53	426-0289-00			1	MOUNT, plastic
	- - - - - -			-	mounting hardware: (not included w/mount)
	210-0801-00			2	WASHER, flat, 5s x 9/32 inch
	210-0004-00			2	LOCKWASHER, intetrnal, #4
	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
54	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
55	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch

REAR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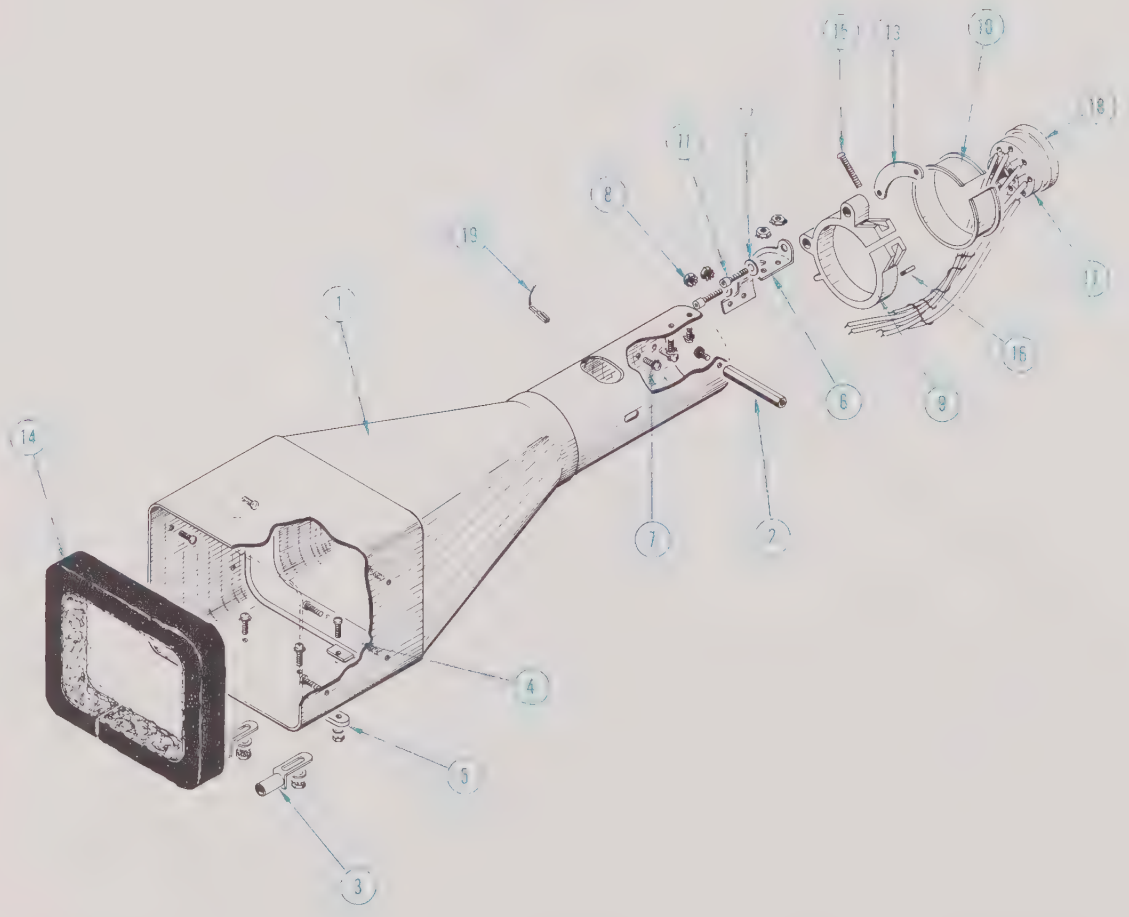
REAR

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	386-0241-00			1	PLATE, sub-panel, rear
2	136-0089-00			1	SOCKET, tube, 9 pin
	- - - - - -			-	mounting hardware: (not included w/socket)
	213-0146-00	100	1263	4	SCREW, thread forming, 6-32 x 0.312 inch, PHS
	213-0088-00	1264		4	SCREW, thread forming, 4-40 x 1/4 inch, PHS
3	131-0081-00			4	CONNECTOR, w/hardware
4	131-0081-00			1	CONNECTOR, w/hardware
	- - - - - -			-	mounting hardware: (not included w/connector)
5	210-0241-00			2	LUG, ground
6	352-0002-00			1	ASSEMBLY, fuse holder
	- - - - - -			-	assembly includes:
	352-0010-00			1	HOLDER, fuse
7	210-0873-00			1	WASHER, rubber
8	- - - - - -			1	NUT
9	200-0582-00			1	CAP, fuse
10	131-0064-00			4	CONNECTOR
	- - - - - -			-	mounting hardware for each: (not included w/connector)
	211-0114-00			2	SCREW, 4-40 x 7/8 inch, 100° CSK, FHS, phillips
	406-0244-00			1	BRACKET, nylon
	210-0224-00			1	LUG, solder, #10
	210-0812-00			2	WASHER, fiber, #10
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
11	- - - - - -			2	TRANSISTOR
	- - - - - -			-	mounting hardware for each: (not included w/transistor)
	211-0510-00			2	SCREW, 6-32 x 3/8 inch, PHS, phillips
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
12	161-0023-00	100	329	1	CORD, power, 18 gauge, 8 foot, 3 conductor
	161-0028-00	330		1	CORD, power
13	348-0078-00			4	FOOT, body and cord holder
	- - - - - -			-	mounting hardware for each: (not included w/foot)
	212-0022-00			1	SCREW, 8-32 x 1 1/2 inches, RHS, phillips
	348-0079-00			1	FOOT, cap
	210-0458-00			1	NUT, keps, 8-32 x 11/32 inch (not shown)
14	358-0161-00			1	BUSHING, strain relief
15	212-0023-00			5	SCREW, 8-32 x 3/8 inch, PHS, phillips
16	334-0904-00			1	TAG, voltage rating
	- - - - - -			-	mounting hardware: (not included w/tag)
	213-0088-00			1	SCREW, thread forming, #4 x 1/4 inch, PHS, phillips
17	212-0023-00	100	107	2	SCREW, 8-32 x 3/8 inch, PHS
	214-0709-00	108		2	PIN, locating
18	134-0026-00	X1264		2	PLUG, brass

CRT SHIELD



CRT SHIELD

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	337-0725-00			1	SHIELD, crt
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0534-00			8	SCREW, 6-32 x 5/16 inch, PHS, w/lockwasher
	210-0457-00			8	NUT, keps, 6-32 x 5/16 inch (not shown)
2	384-0647-00			1	ROD, spacer, hex.
	210-0803-00			1	WASHER, 6L x 3/8 inch
3	136-0112-00			2	SOCKET, graticule lamp
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	211-0534-00			1	SCREW, 6-32 x 5/16 inch, PHS, w/lockwasher
	210-0803-00			1	WASHER, 6L x 3/8 inch
	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
4	- - - - - -			1	COIL
	- - - - - -			-	mounting hardware: (not included w/coil)
5	352-0044-00			1	HOLDER
	211-0097-00			1	SCREW, 4-40 x 5/16 inch, PHS
	210-0004-00			1	LOCKWASHER, internal, #4
	210-0406-00			1	NUT, hex., 4-40 x 3/16 inch
6	406-0730-00			1	BRACKET, parallax adjusting
	- - - - - -			-	mounting hardware: (not included w/bracket)
7	211-0534-00			4	SCREW, 6-32 x 5/16 inch, PHS, w/lockwasher
8	210-0457-00			4	NUT, keps, 6-32 x 5/16 inch
	210-0803-00			4	WASHER, 6L x 3/8 inch (not shown)
9	354-0249-00			1	RING, crt clamping
	- - - - - -			-	ring includes:
10	124-0171-00			1	STRIP, liner, crt clamp
	- - - - - -			-	mounting hardware: (not included w/ring)
11	211-0576-00			2	SCREW, 6-32 x 7/8 inch, socket head cap
12	210-0949-00			2	WASHER, 9/64 ID x 1/2 inch OD
13	214-0207-00			2	NUT, adjusting securing
14	124-0167-00			1	STRIP, crt shield, neoprene
15	211-0560-00			1	SCREW, 6-32 x 1 inch, RHS
16	220-0419-00			1	NUT, square, 6-32 x 5/16 inch
17	179-1031-00			1	CABLE HARNESS, crt socket
	- - - - - -			-	cable harness includes:
	136-0233-00			1	SOCKET, crt
	- - - - - -			-	socket includes:
	136-0202-01			1	SOCKET, crt
18	200-0616-00			1	COVER, socket
19	175-0585-00			1	WIRE, CRT lead, 0.290 foot, striped brown, w/connector
	175-0593-00			1	WIRE, CRT lead, 0.333 foot, striped blue, w/connector
	175-0592-00			1	WIRE, CRT lead, 0.960 foot, striped green, w/connector
	175-0595-00			1	WIRE, CRT lead, 0.960 foot, striped red, w/connector

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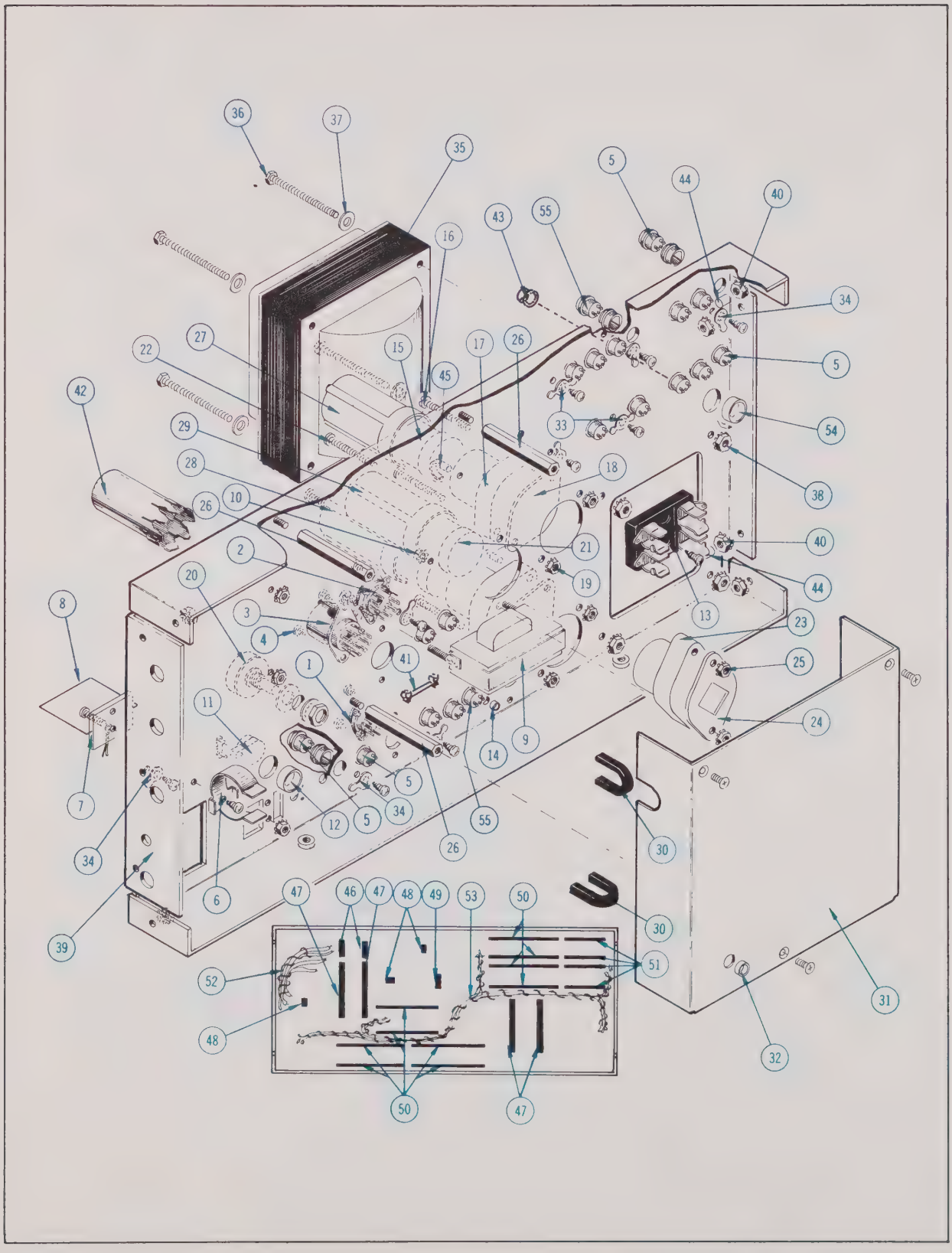
HORIZONTAL CHASSIS



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HORIZONTAL CHASSIS

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	136-0007-00			1	SOCKET, STM7
	- - - - - -			-	mounting hardware: (not included w/socket)
	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS, phillips
2	136-0014-00			1	SOCKET, STM9
	- - - - - -			-	mounting hardware: (not included w/socket)
	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS, phillips
3	136-0022-00			1	SOCKET, STM9S
	- - - - - -			-	mounting hardware: (not included w/socket)
4	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS, phillips
5	136-0181-00			15	SOCKET, transistor, 3 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0234-00			1	RING, locking
6	344-0117-00			1	CLIP, capacitor mounting
	- - - - - -			-	mounting hardware: (not included w/clip)
	213-0044-00			1	SCREW, thread forming, 5-32 x 3/16 inch, PHS, phillips
7	136-0215-00			1	SOCKET, relay
	- - - - - -			-	mounting hardware: (not included w/socket)
	211-0097-00			1	SCREW, 4-40 x 5/16 inch, PHS
	214-0538-00			1	SPRING, ground wire
	210-0586-00			1	NUT, keps, 4-40 x 1/4 inch
8	214-0539-00			1	SPRING, retainer wire
9	- - - - - -			1	TRANSFORMER
	- - - - - -			-	mounting hardware: (not included w/transformer)
	346-0001-00			1	STRAP, mounting
10	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
11	- - - - - -			1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included w/capacitor)
	214-0153-00			1	FASTENER, snap
12	348-0063-00	100	1099	1	GROMMET, delrin, 1/2 inch diameter
	348-0064-00	1100		1	GROMMET, delrin, 5/8 inch diameter
13	352-0025-00			1	HOLDER, fuse
	- - - - - -			-	mounting hardware: (not included w/holder)
	213-0146-00			2	SCREW, Type B, #6 x 5/16 inch, PHS, phillips
14	348-0031-00			2	GROMMET, plastic, snap-in, 5/32 inch diameter

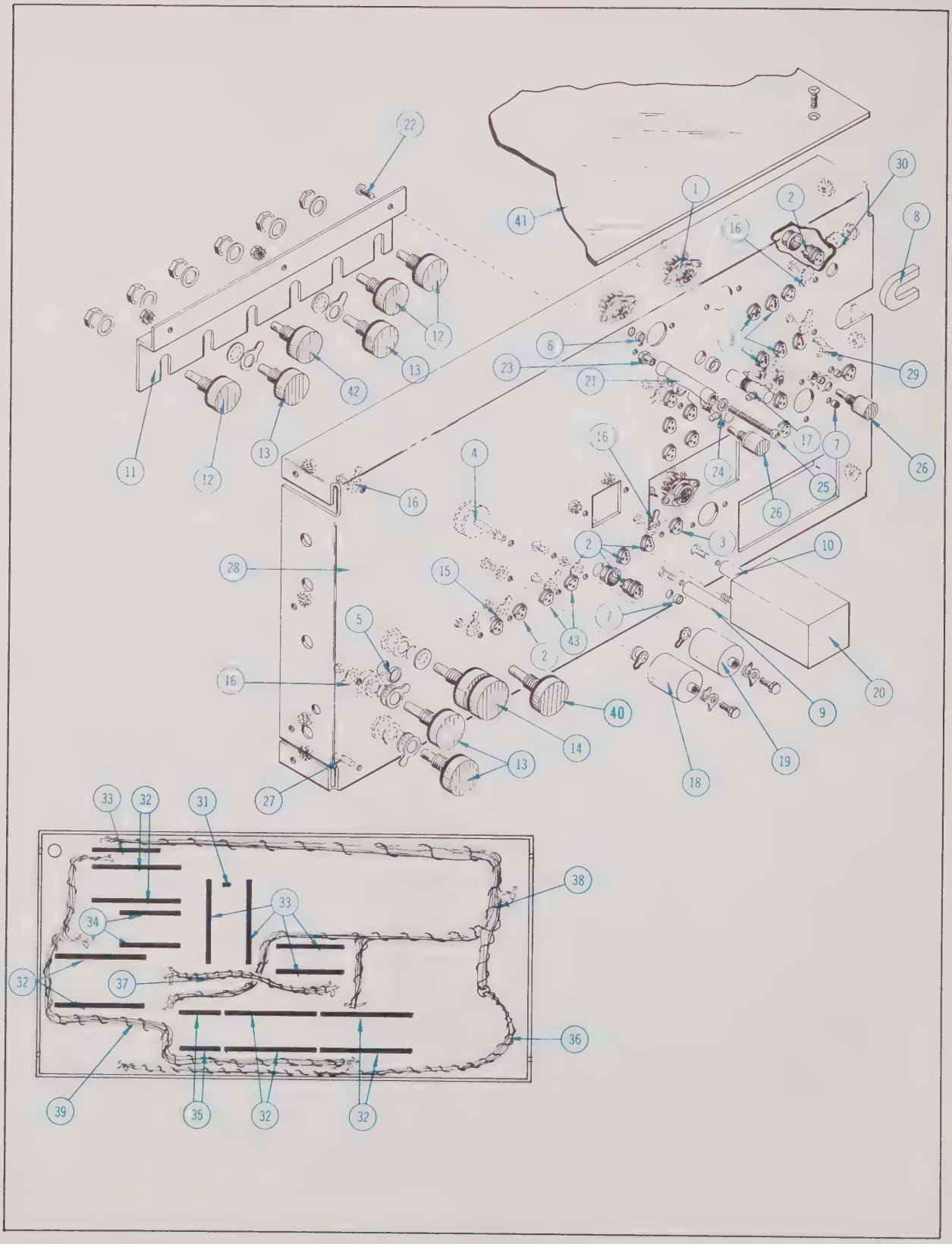
HORIZONTAL CHASSIS *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
15	- - - - - -			2	CAPACITOR
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
16	211-0588-00			2	SCREW, 6-32 x 3/4 inch, HHS
17	432-0048-00			1	BASE, capacitor mounting, large
18	386-0254-00			1	PLATE, fiber, large
19	210-0457-00			2	NUT, hex., 6-32 x 5/16 inch
20	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0840-00			1	WASHER, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
21	- - - - - -			1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included w/capacitor)
22	211-0516-00			2	SCREW, 6-32 x 7/8 inch, PHS
23	432-0048-00			1	BASE, capacitor mounting, large
24	386-0254-00			1	PLATE, fiber, large
25	210-0457-00			2	NUT, hex., 6-32 x 5/16 inch
26	384-0616-00			3	ROD, spacer, hex.
27	200-0260-00			1	COVER, capacitor, plastic 1.365 ID x 2 1/32 inch OD
28	200-0293-00			1	COVER, capacitor, plastic 1.365 ID x 2 1/32 inch OD
29	200-0538-00			1	COVER, insulation
30	358-0215-00			2	BUSHING, plastic
31	337-0787-00			1	SHIELD, high voltage
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0038-00			3	SCREW, 4-40 x 5/16 inch, FHS
32	348-0055-00			1	GROMMET, plastic, 1/4 inch, mounting
33	210-0204-00			2	LUG, solder, DE #6
	- - - - - -			-	mounting hardware for each: (not included w/lug)
	213-0044-00			1	SCREW, thread forming, 5-32 x 3/16 inch, PHS
34	210-0201-00			9	LUG, solder, SE #4
	- - - - - -			-	mounting hardware for each: (not included w/lug)
	213-0044-00			1	SCREW, thread forming, 5-32 x 3/16 inch, PHS
35	- - - - - -			1	TRANSFORMER
	- - - - - -			-	transformer includes:
36	212-0516-00			4	SCREW, 10-32 x 2 inches, HHS
37	210-0812-00			4	WASHER, fiber, #10
	- - - - - -			-	mounting hardware: (not included w/transformer)
38	220-0410-00			4	NUT, keps, 10-32 x 3/8 inch
39	441-0652-00	100	3845	1	CHASSIS
	441-0652-01	3846		1	CHASSIS
	- - - - - -			-	mounting hardware: (not included w/chassis)
	212-0040-00			2	SCREW, 8-32 x 3/8 inch, 100° CSK, FHS (not shown)
	212-0023-00			3	SCREW, 8-32 x 3/8 inch, PHS, phillips (not shown)
	212-0070-00			3	SCREW, 8-32 x 3/8 inch, 100° CSK, FHS (not shown)
	210-0458-00			5	NUT, keps, 8-32 x 11/32 inch

HORIZONTAL CHASSIS *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
40	210-0458-00			2	NUT, keps, 8-32 x $^{11}/_{32}$ inch
41	344-0111-00	100	2068	1	CLIP, deflection plate
	344-0111-00	2069		2	CLIP, deflection plate
42	337-0491-00			1	SHIELD, tube
43	200-0385-00	100	2069X	1	COVER, transistor
44	200-0663-00			2	CAP, screw tip
45	343-0089-00			2	CLAMP, cable, size (D)
46	124-0093-00			2	STRIP, ceramic, $^{7}/_{16}$ inch h, w/5 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
47	124-0106-00			4	STRIP, ceramic, $^{7}/_{16}$ inch h, w/11 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
48	124-0118-00			3	STRIP, ceramic, $^{7}/_{16}$ inch h, w/1 notch
	- - - - - -			-	each strip includes:
	355-0046-00			1	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			1	SPACER, plastic, 0.406 inch long
49	124-0119-00			1	STRIP, ceramic, $^{7}/_{16}$ inch h, w/2 notches
	- - - - - -			-	strip includes:
	355-0046-00			1	STUD, plastic
	- - - - - -			-	mounting hardware: (not included w/strip)
	361-0009-00			1	SPACER, plastic, 0.406 inch long
50	124-0145-00			10	STRIP, ceramic, $^{7}/_{16}$ inch h, w/20 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
51	124-0147-00			4	STRIP, ceramic, $^{7}/_{16}$ inch h, w/13 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
52	179-1030-00			1	CABLE HARNESS (F & I)
53	179-1025-00			1	CABLE HARNESS (horizontal)
54	348-0064-00			1	GROMMET, delrin, $^{5}/_{8}$ inch diameter
55	136-0182-00			2	SOCKET, transistor, 4 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0234-00			1	RING, locking

VERTICAL CHASSIS



VERTICAL CHASSIS

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	136-0015-00			4	SOCKET, STM9G
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
2	136-0181-00			17	SOCKET, transistor, 3 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0234-00			1	RING, locking
3	136-0182-00			5	SOCKET, transistor, 4 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0234-00			1	RING, locking
4	214-0210-00			1	ASSEMBLY, solder spool
	- - - - - -			-	assembly includes:
	214-0209-00			1	SPOOL, solder
	- - - - - -			-	mounting hardware: (not included w/assembly)
	361-0007-00			1	SPACER, nylon
5	348-0063-00			1	GROMMET, delrin, 1/2 inch diameter
6	348-0055-00			2	GROMMET, plastic, 1/4 inch, mounting
7	348-0031-00			3	GROMMET, plastic, snap-in, 5/32 inch diameter
8	358-0215-00			1	BUSHING, plastic
9	385-0075-00			1	ROD, nylon, 5/16 diameter x 1 1/8 inches long
	- - - - - -			-	mounting hardware: (not included w/rod)
	213-0041-00			1	SCREW, thread cutting, 6-32 x 3/8 inch, THS
10	385-0138-00	100	2068	1	ROD, delrin, 5/16 diameter x 1 9/16 inches long
	385-0075-00	2069		1	ROD, nylon, 5/16 diameter x 1 1/8 inches long
	- - - - - -			-	mounting hardware: (not included w/rod)
	213-0041-00			1	SCREW, thread cutting, 6-32 x 3/8 inch, THS
11	407-0198-00			1	BRACKET, pot
	- - - - - -			-	mounting hardware: (not included w/bracket)
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
12	- - - - - -			3	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
	210-0840-00			1	WASHER, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
13	- - - - - -			4	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
	210-0012-00			1	LOCKWASHER, pot, internal, 3/8 x 1/2 inch
	210-0207-00			1	LUG, solder, pot, plain, 3/8 inch
	210-0840-00			1	WASHER, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
14	- - - - - -	100	2439	1	RESISTOR, variable
	- - - - - -	2440		2	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0840-00			1	WASHER, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch

VERTICAL CHASSIS *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
15	210-0204-00			1	LUG, solder, DE #6
	- - - - - -			-	mounting hardware: (not included w/lug)
	213-0044-00			1	SCREW, thread forming, 5-32 x 3/16 inch, PHS
16	210-0201-00			9	LUG, solder, SE #4
	- - - - - -			-	mounting hardware for each: (not included w/lug)
	213-0044-00			1	SCREW, thread forming, 5-32 x 3/16 inch, PHS
17	- - - - - -			2	COIL
	- - - - - -			-	mounting hardware for each: (not included w/coil)
	354-0234-00			1	RING, locking
18	- - - - - -			1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included w/capacitor)
	385-0018-00	X2530	3849X	1	ROD, plastic, 5/16 diameter x 1 1/4 inch
	211-0510-00			1	SCREW, 6-32 x 3/8 inch, PHS
	210-0935-00			2	WASHER, fiber, 0.140 ID x 0.375 inch OD
	210-0224-00	100	2529	1	LUG, solder, #10
	210-0261-00	100	2529	2	LUG, solder, 9/64 ID x 0.270 inch OD
	210-0202-00	2530	3849	3	LUG, solder, SE #6
	210-0224-00	3850		1	LUG, solder, #10
	210-0261-00	3850		2	LUG, solder
	211-0587-00			1	SCREW, 6-32 x 3/16 inch, w/special hex. head
19	- - - - - -			1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included w/capacitor)
	385-0018-00	X2530	3849X	1	ROD, plastic, 5/16 diameter x 1 1/4 inch
	211-0510-00			1	SCREW, 6-32 x 3/8 inch, PHS
	210-0006-00	100	2529	1	LOCKWASHER, internal, #6
	210-0261-00	100	2529	2	LUG, solder, 9/64 ID x 0.270 inch OD
	210-0202-00	2530	3849	3	LUG, solder, SE #6
	210-0261-00	3850		2	LUG, solder
	210-0006-00	3850		1	LOCKWASHER, internal, #6
	211-0587-00			1	SCREW, 6-32 x 3/16 inch, w/special hex. head
20	- - - - - -			1	COIL
	- - - - - -			-	mounting hardware: (not included w/coil)
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
21	- - - - - -			1	RESISTOR
	- - - - - -			-	mounting hardware: (not included w/resistor)
22	211-0510-00			1	SCREW, 6-32 x 3/8 inch, PHS
23	210-0478-00			1	NUT, hex., 5/16 x 21/32 inch long
24	210-0601-00			1	EYELET
25	211-0553-00			1	SCREW, 6-32 x 1 1/2 inches, RHS
26	- - - - - -			2	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
	210-0940-00			1	WASHER, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
27	343-0089-00			1	CLAMP, cable, size (D)
28	441-0651-00			1	CHASSIS
	- - - - - -			-	mounting hardware: (not included w/chassis)
	212-0040-00			4	SCREW, 8-32 x 3/8 inch, 100° CSK, FHS (not shown)
	212-0023-00			4	SCREW, 8-32 x 3/8 inch, PHS (not shown)
	210-0458-00			8	NUT, keps, 8-32 x 11/32 inch

VERTICAL CHASSIS *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
29	426-0121-00			1	MOUNT, toroid, plastic
	- - - - - -			-	mounting hardware: (not included w/mount)
	361-0007-00			1	SPACER, plastic, 0.188 inch long
30	200-0663-00			2	COVER, screw tip
31	124-0118-00			1	STRIP, ceramic, 7/16 inch h, w/1 notch
	- - - - - -			-	strip includes:
	355-0046-00			1	STUD, plastic
	- - - - - -			-	mounting hardware: (not included w/strip)
	361-0007-00			1	SPACER, plastic, 0.188 inch long
32	124-0145-00			8	STRIP, ceramic, 7/16 inch h, w/20 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
33	124-0146-00			5	STRIP, ceramic, 7/16 inch h, w/16 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not includede w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
34	124-0147-00			2	STRIP, ceramic, 7/16 inch h, w/13 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
35	124-0148-00			2	STRIP, ceramic, 7/16 inch h, w/9 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long
36	179-1029-00			1	CABLE HARNESS (coaxial)
37	179-1028-00			1	CABLE HARNESS (switch)
38	179-1026-00			1	CABLE HARNESS (vertical #1)
	- - - - - -			-	cable harness includes:
	175-0589-00			1	WIRE, CRT lead, 1.380 feet, striped orange, w/connector
39	179-1027-00			1	CABLE HARNESS (vertical #2)
40	- - - - - -	X998		1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0207-00			1	LUG, solder, 3/8 ID x 5/8 inch OD, SE
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
41	386-1085-00	X1264		1	PLATE, electrical shield
	- - - - - -			-	mounting hardware. (not included w/plate)
	212-0002-00			4	SCREW, 8-32 x 1/4 inch, FHS

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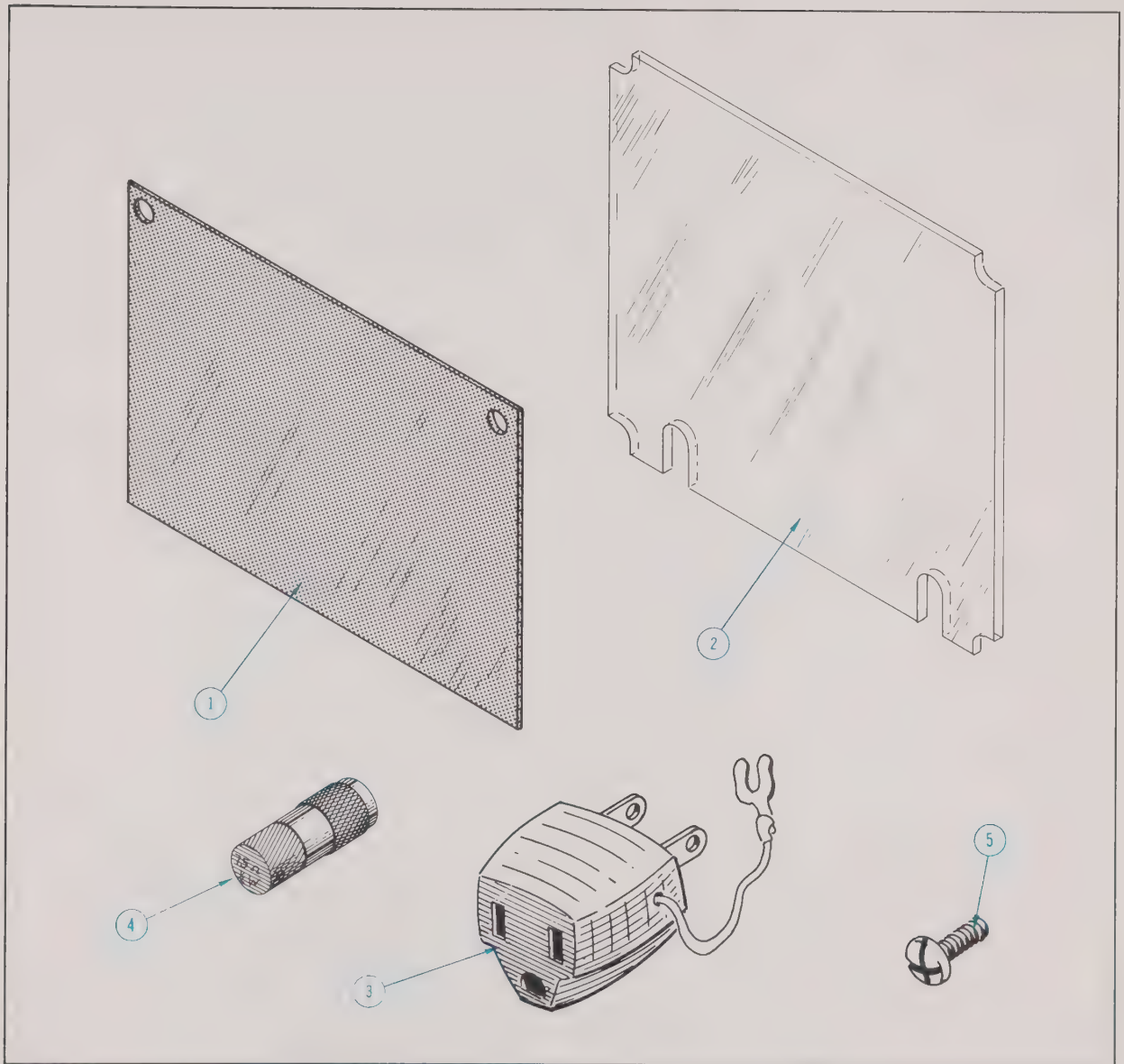
VERTICAL CHASSIS *(cont)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
42	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0207-00	X1600		1	LUG, solder, 3/8 inch
	210-0840-00			1	WASHER, 0.390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
43	136-0181-00	100	1599	2	SOCKET, transistor, 3 pin
	136-0182-00	1600		2	SOCKET, transistor, 4 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0234-00			1	RING, locking

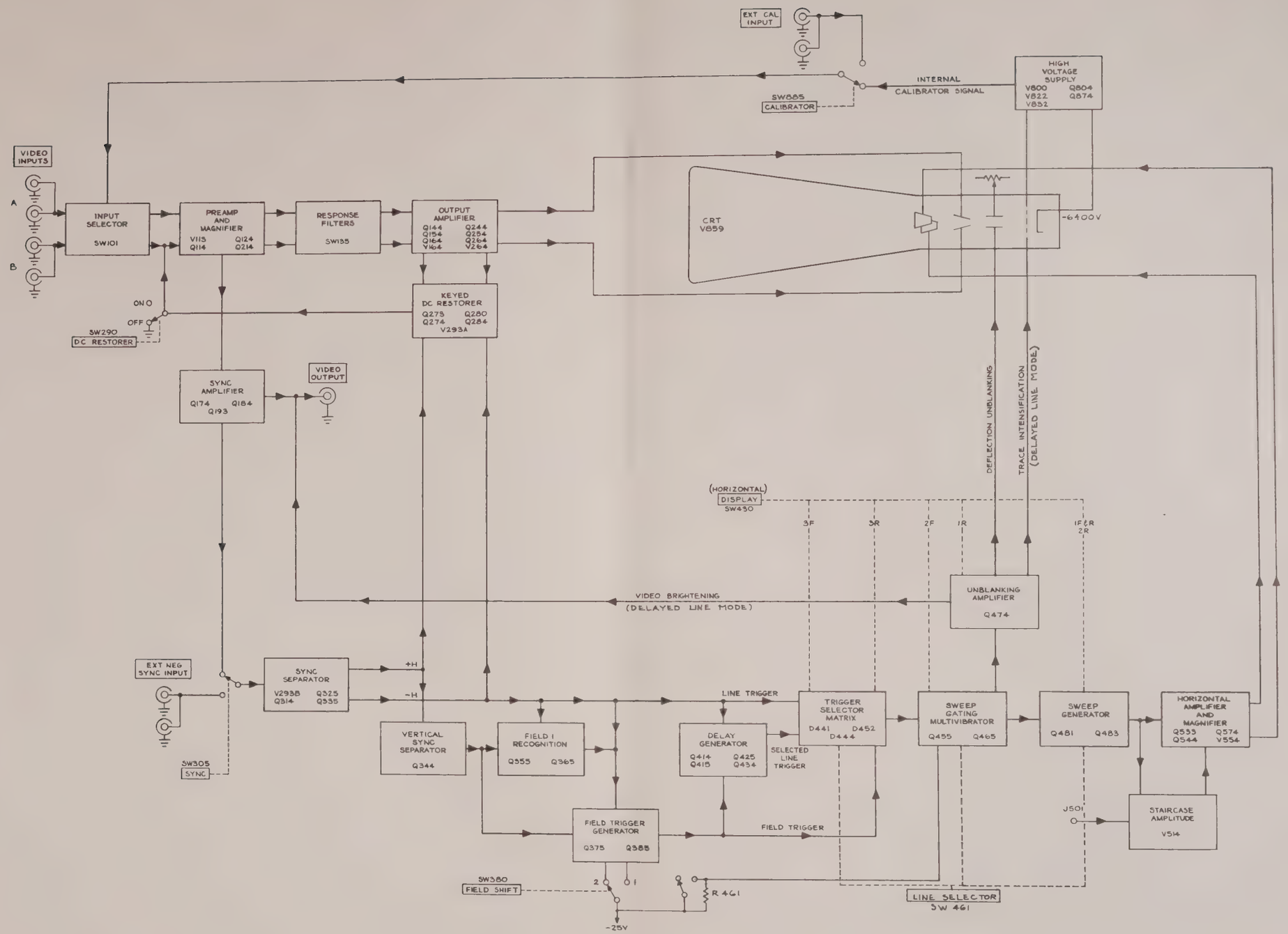
©

STANDARD ACCESSORIES



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	378-0560-00	100	2439	1	FILTER, light, smoke gray (installed)
	378-0560-00	2440		1	FILTER, light, smoke gray
2	331-0077-01			1	GRATICULE, non-composite
	331-0156-01			1	GRATICULE, 7 cm, composite
	331-0157-00			1	GRATICULE, double-scale
	331-0161-00			1	GRATICULE, 7 cm (installed)
3	103-0013-00			1	ADAPTER, power cord, 3 to 2 wire
4	011-0023-00	X1533		1	RESISTOR, terminating, 75 Ω
5	212-0023-00	X1930		4	SCREW, 8-32 x 3/8 inch, PHS
	070-0509-01			2	MANUAL, instruction (not shown)
	377-0064-00			2	INSERT, graticule light (not shown)

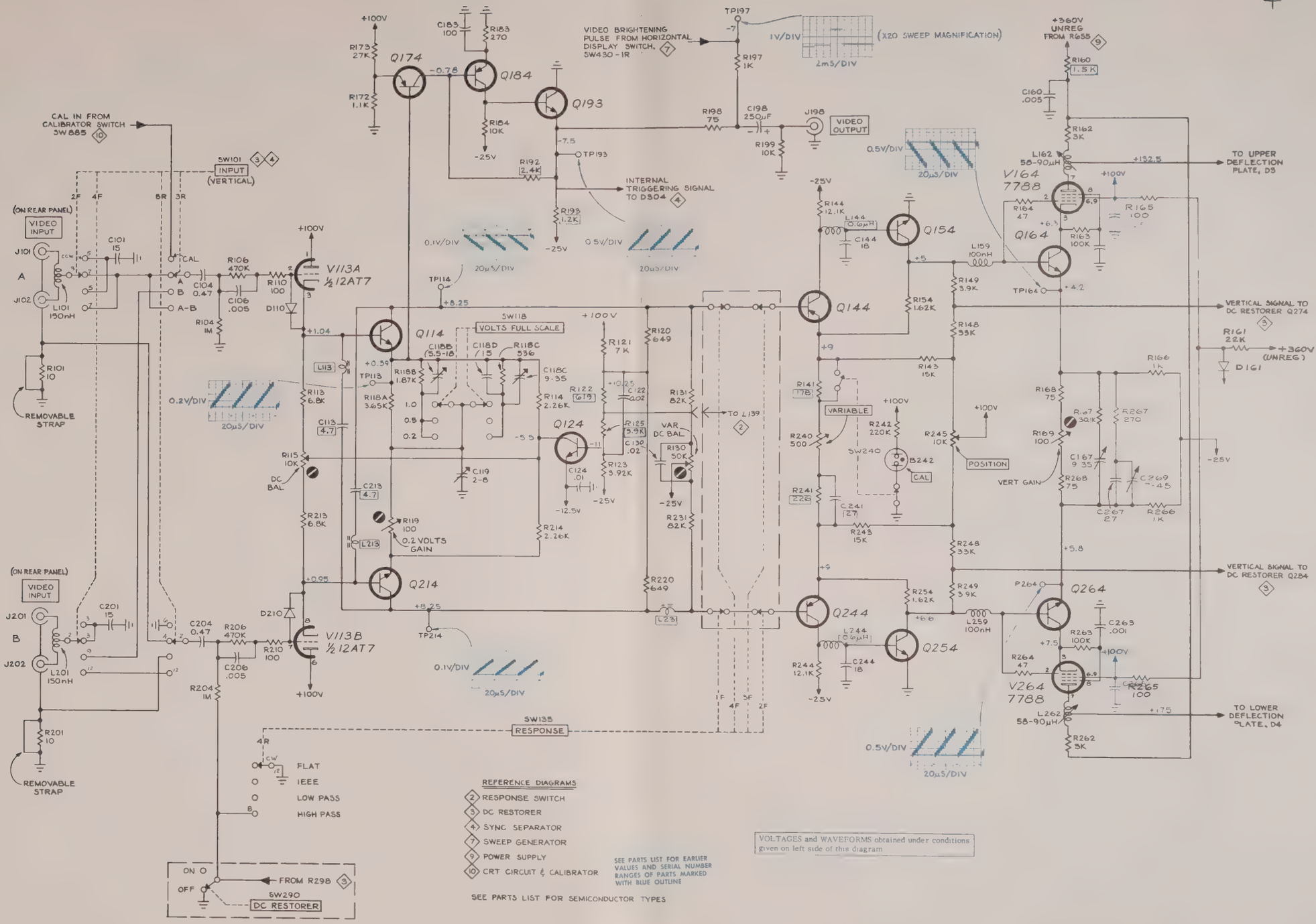
NOTES



TYPE 529 WAVEFORM MONITOR

768

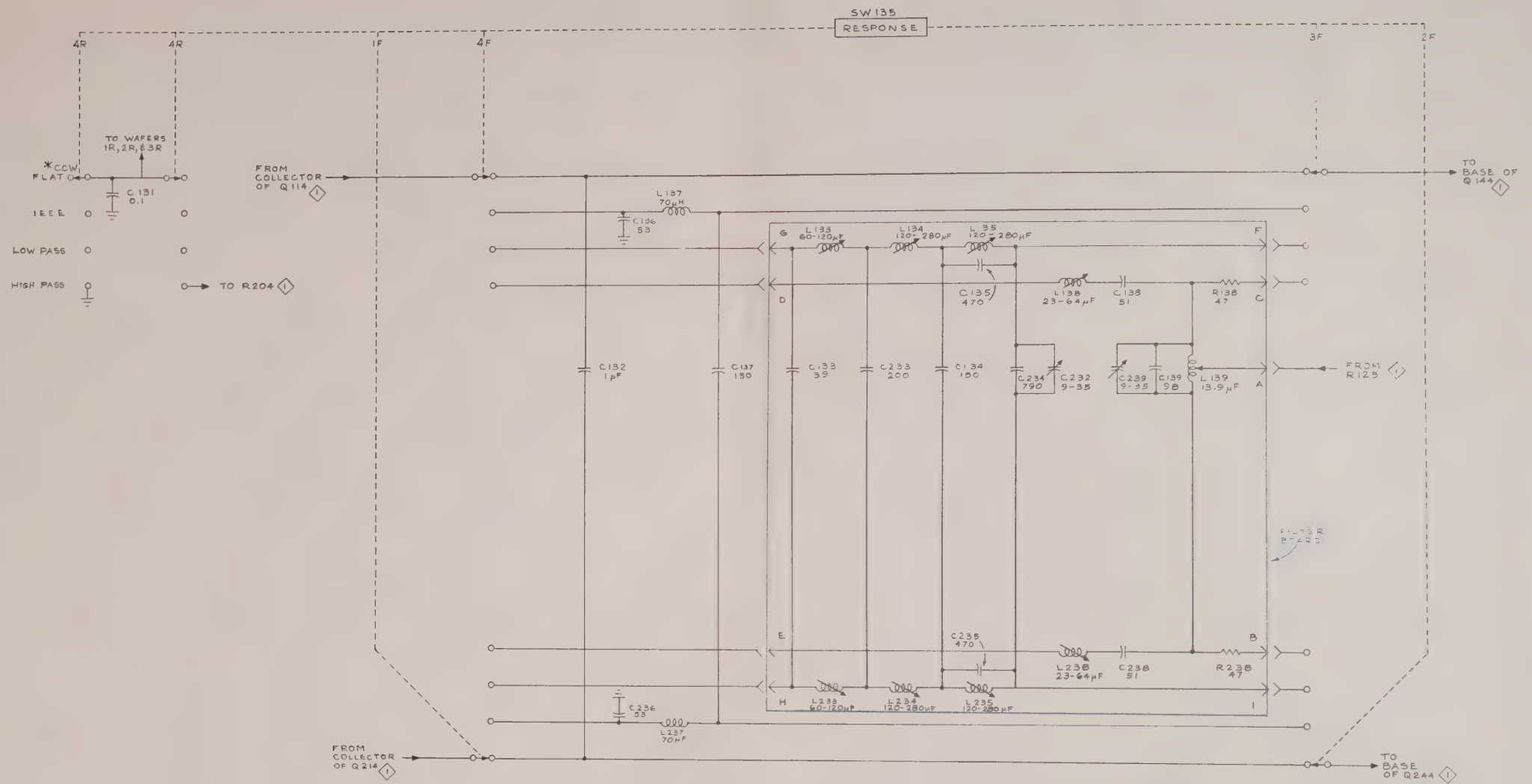
BLOCK DIAGRAM



+ TYPE 529 WAVEFORM MONITOR

GN 768

VERTICAL AMPLIFIER 1



NOTES:

1. ALL INACTIVE FILTER NETWORKS ARE AC GROUNDED AT INPUT & OUTPUT THRU C131
2. SWITCH IS MOUNTED IN INSRUMENT WITH WAFER 4 NEAREST FRONT PANEL
3. * SWITCH ROTATION AS VIEWED FROM INDEX END OF SWITCH – THIS POSITION IS CLOCKWISE ON FRONT PANEL

REFERENCE DIAGRAMS

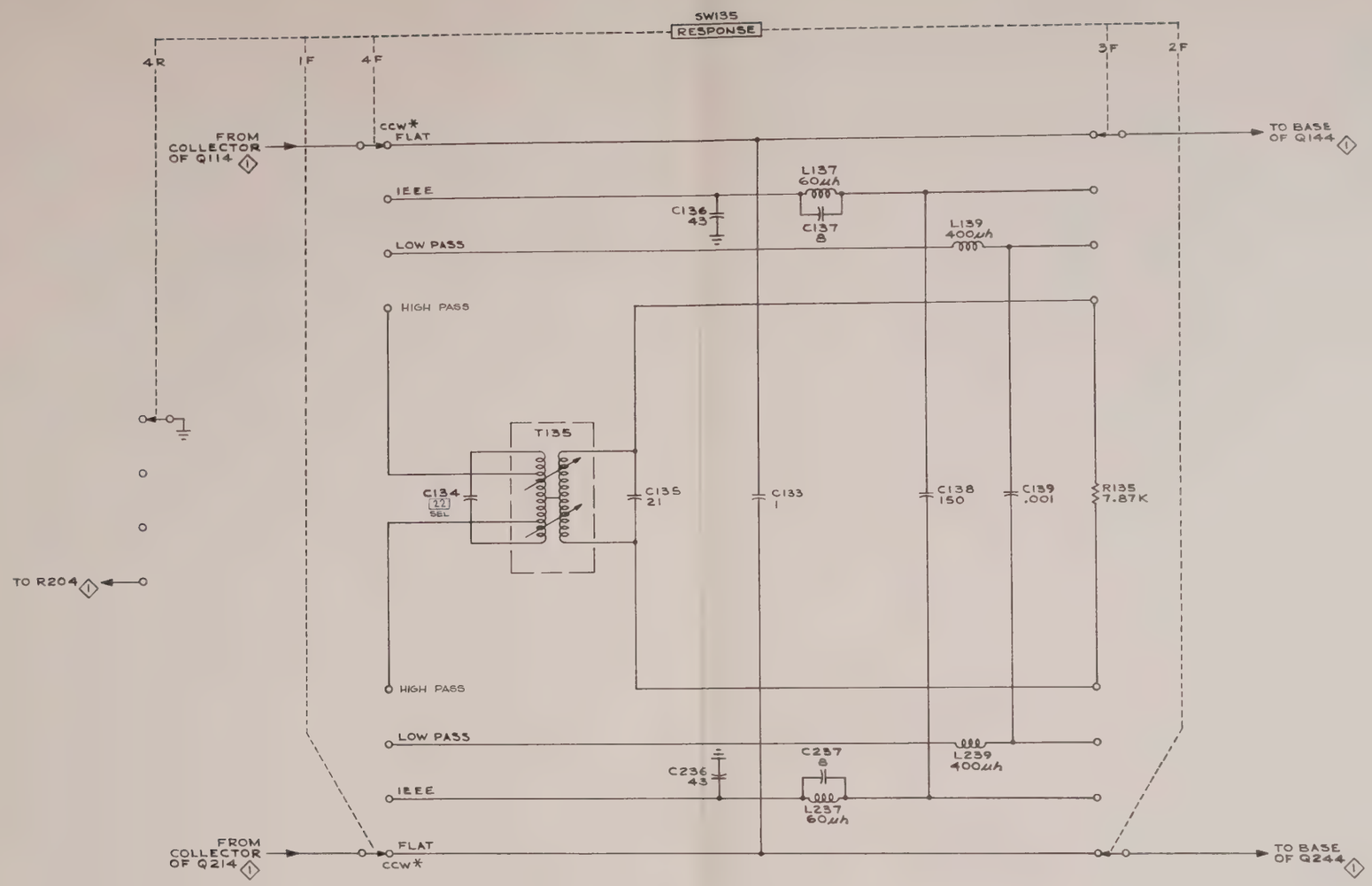
(1) VERTICAL AMPLIFIER

hg
768

TYPE 529 WAVEFORM MONITOR

A

RESPONSE SWITCH (2)
S/N 6000-UP



REFERENCE DIAGRAM:

① VERTICAL AMPLIFIER & DC RESTORER

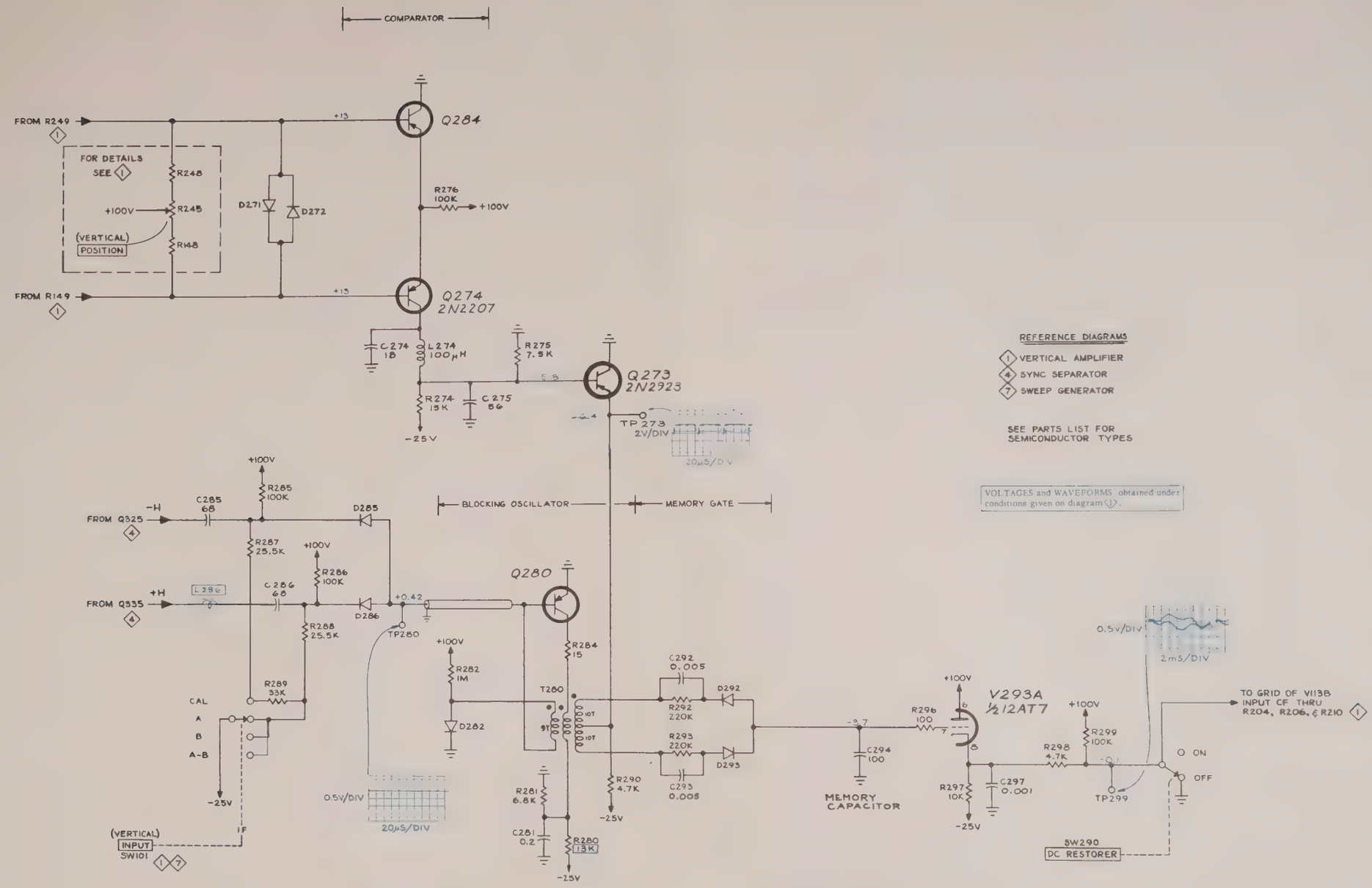
NOTES:

1. ALL INACTIVE FILTER SECTIONS GROUNDED AT INPUT AND OUTPUT
2. SWITCH IS MOUNTED IN INSTRUMENT WITH WAFER 4 NEAREST FRONT PANEL
3. * SWITCH ROTATION AS VIEWED FROM INDEX END OF SWITCH - THIS POSITION IS CLOCKWISE ON FRONT PANEL

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE

MRH
768

RESPONSE SWITCH ②
S/N 100-5999

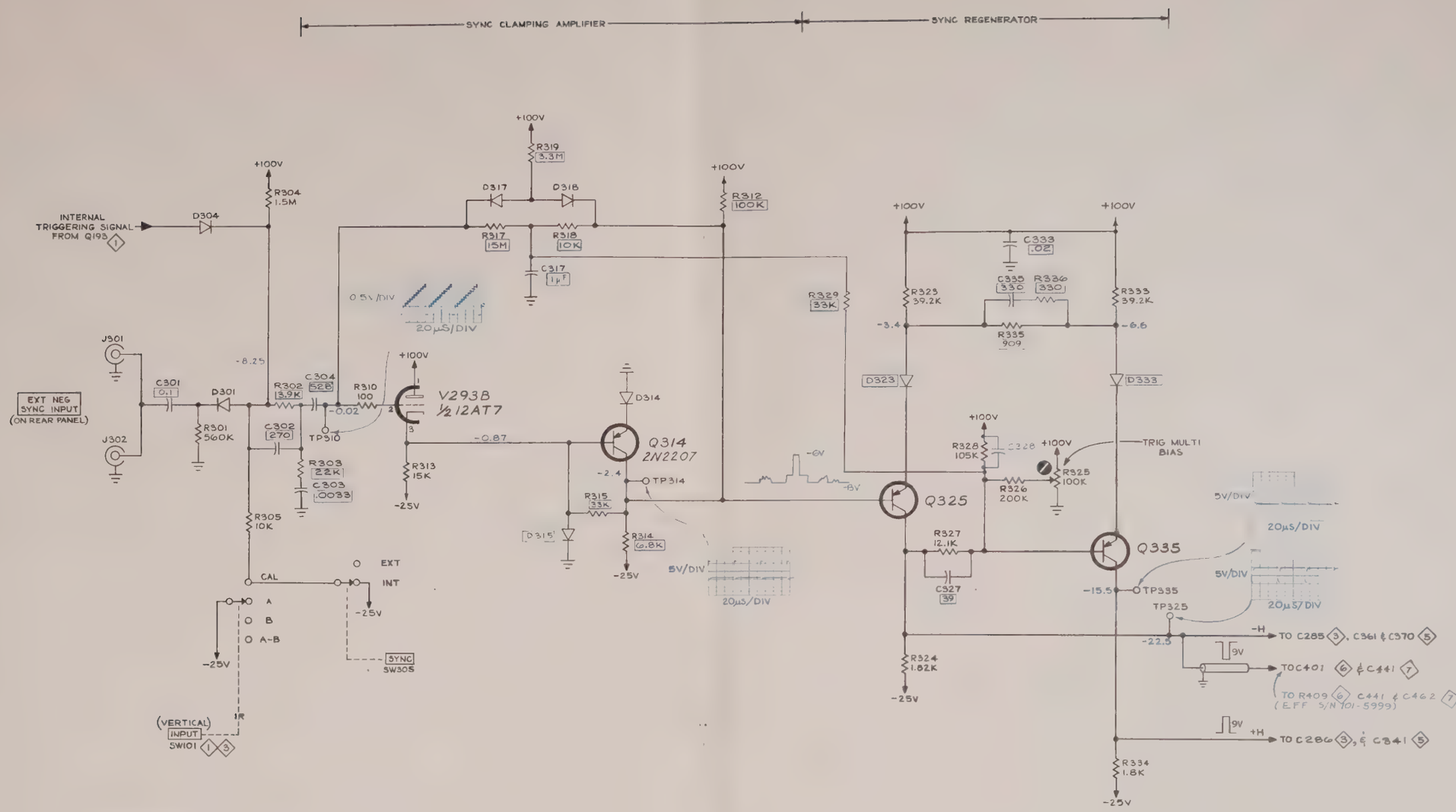


SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE

TYPE 529 WAVEFORM MONITOR

768

DC RESTORER 3



REFERENCE DIAGRAMS

- 1 VERTICAL AMPLIFIER
- 3 DC RESTORER
- 5 FIELD SELECTOR
- 6 LINE SELECTOR
- 7 SWEEP GENERATOR

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

VOLTAGES and WAVEFORMS obtained under conditions given on diagram 1.

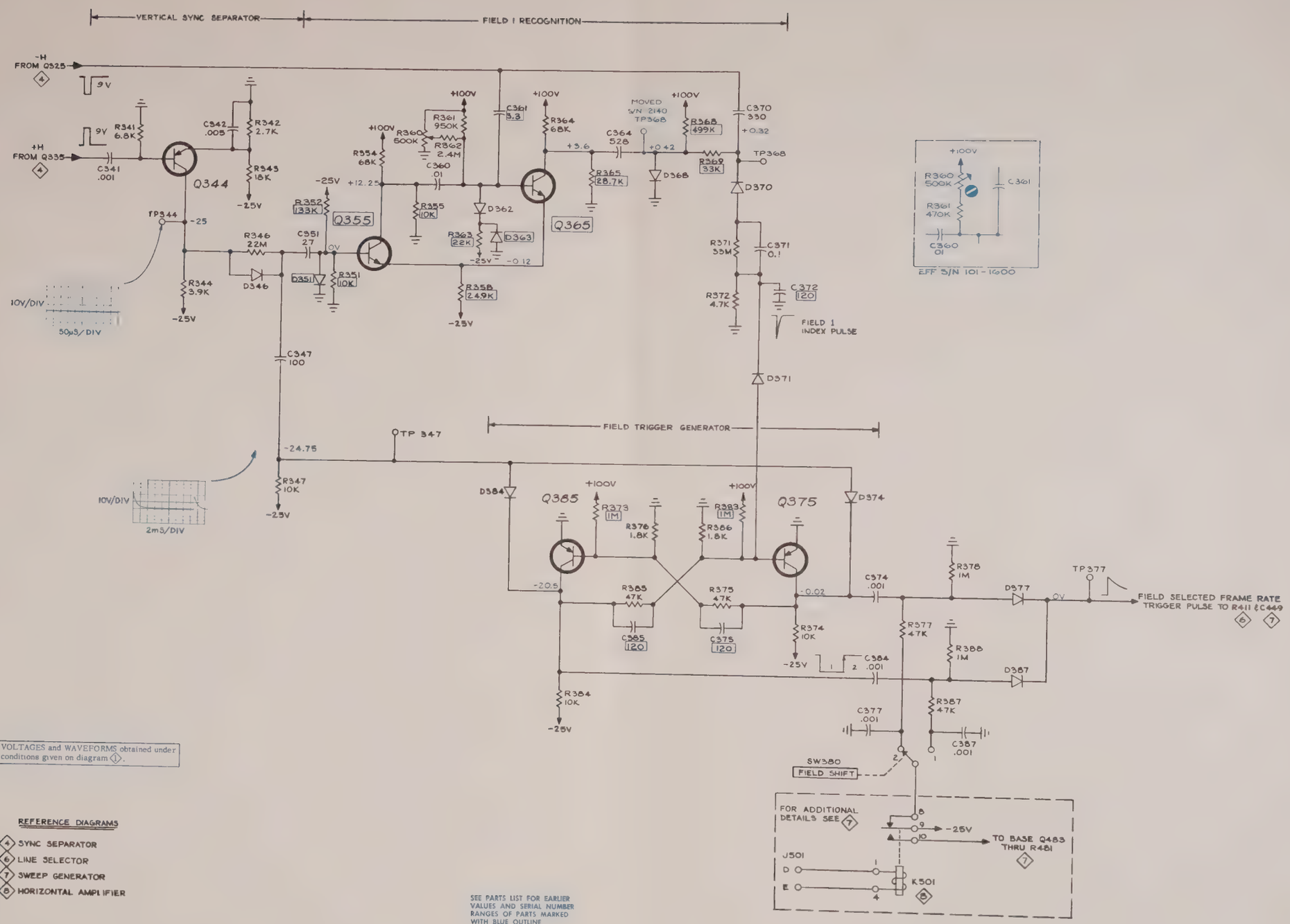
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE

TYPE 529 WAVEFORM MONITOR

E

GN 768

SYNC SEPARATOR 4



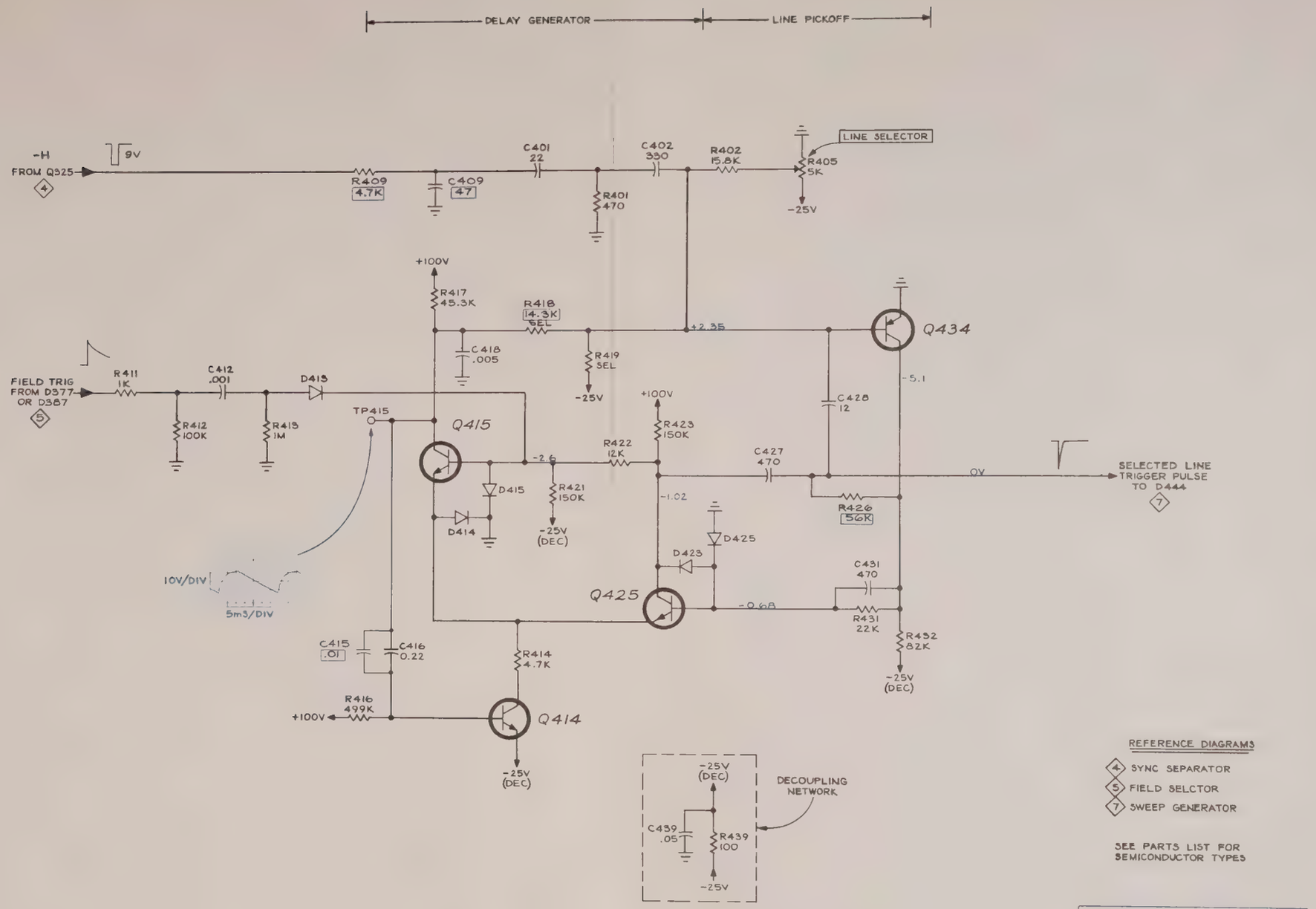
VOLTAGES and WAVEFORMS obtained under conditions given on diagram 1.

REFERENCE DIAGRAMS

- 4 SYNC SEPARATOR
- 6 LINE SELECTOR
- 7 SWEEP GENERATOR
- 8 HORIZONTAL AMPLIFIER

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE

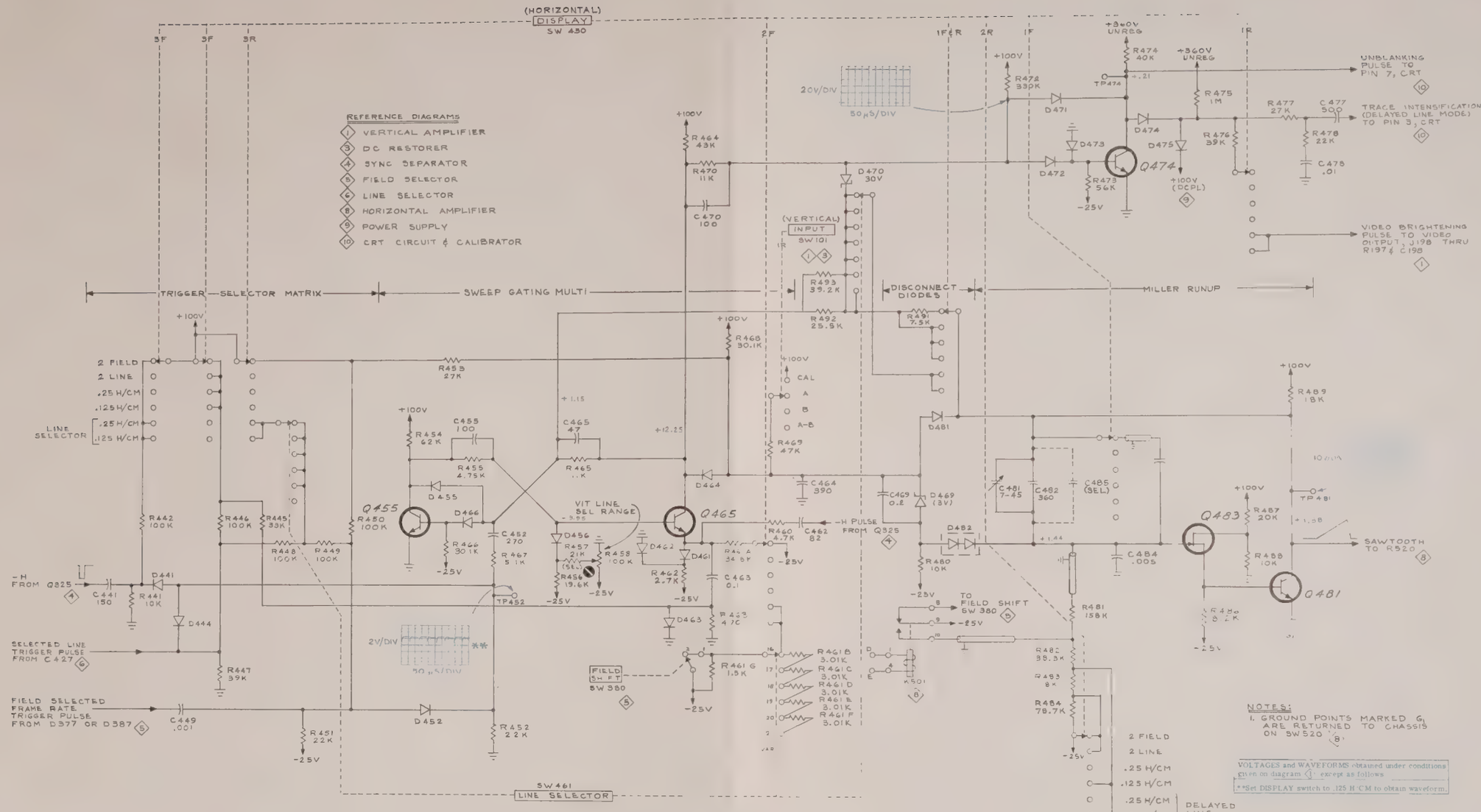


REFERENCE DIAGRAMS

- 4 SYNC SEPARATOR
- 5 FIELD SELCTOR
- 7 SWEEP GENERATOR

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

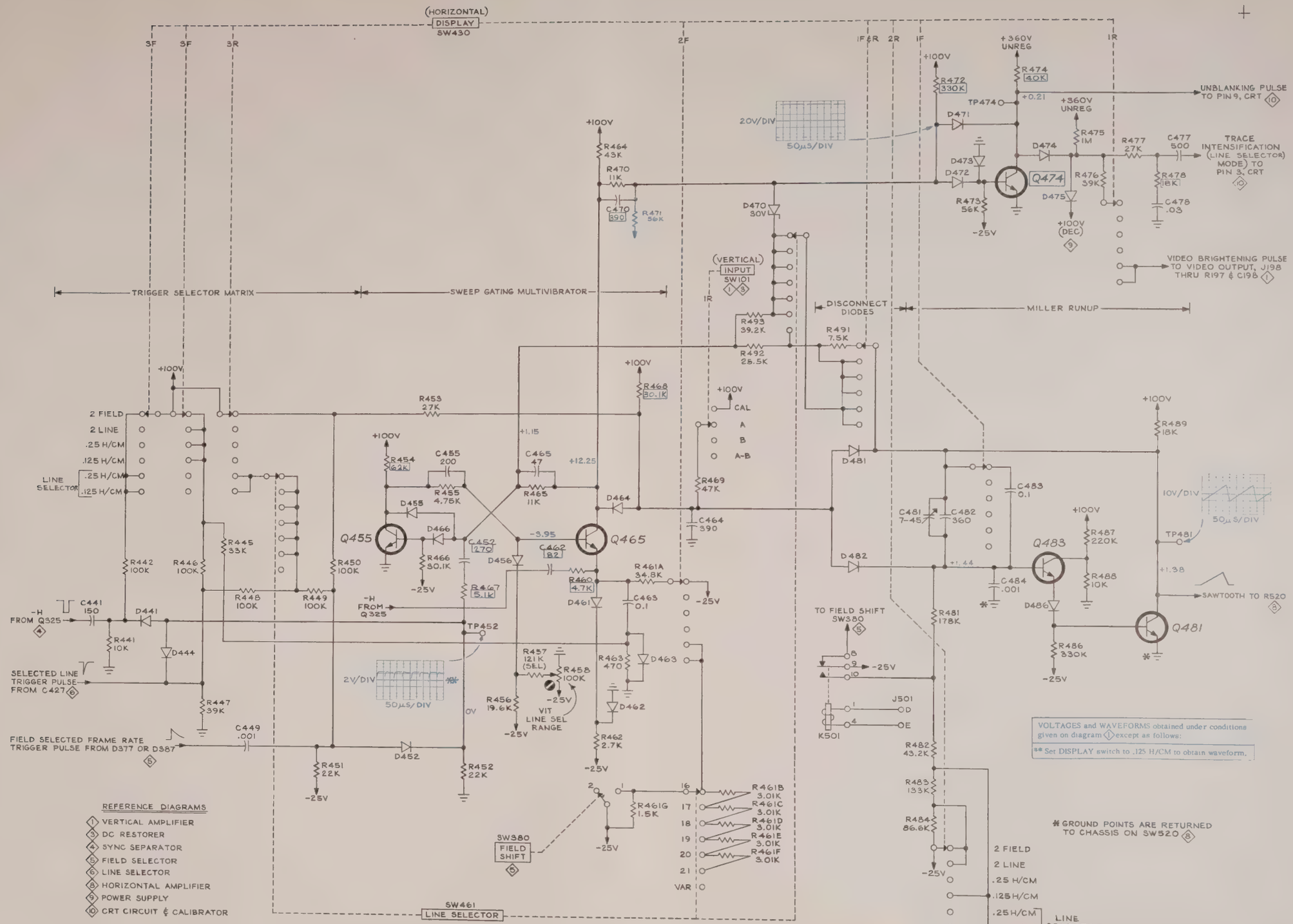
VOLTAGES and WAVEFORMS obtained under conditions given on diagram 1.



529 WAVEFORM MONITOR

A1

SWEEP GENERATOR 7G8
S/N 6000-UP

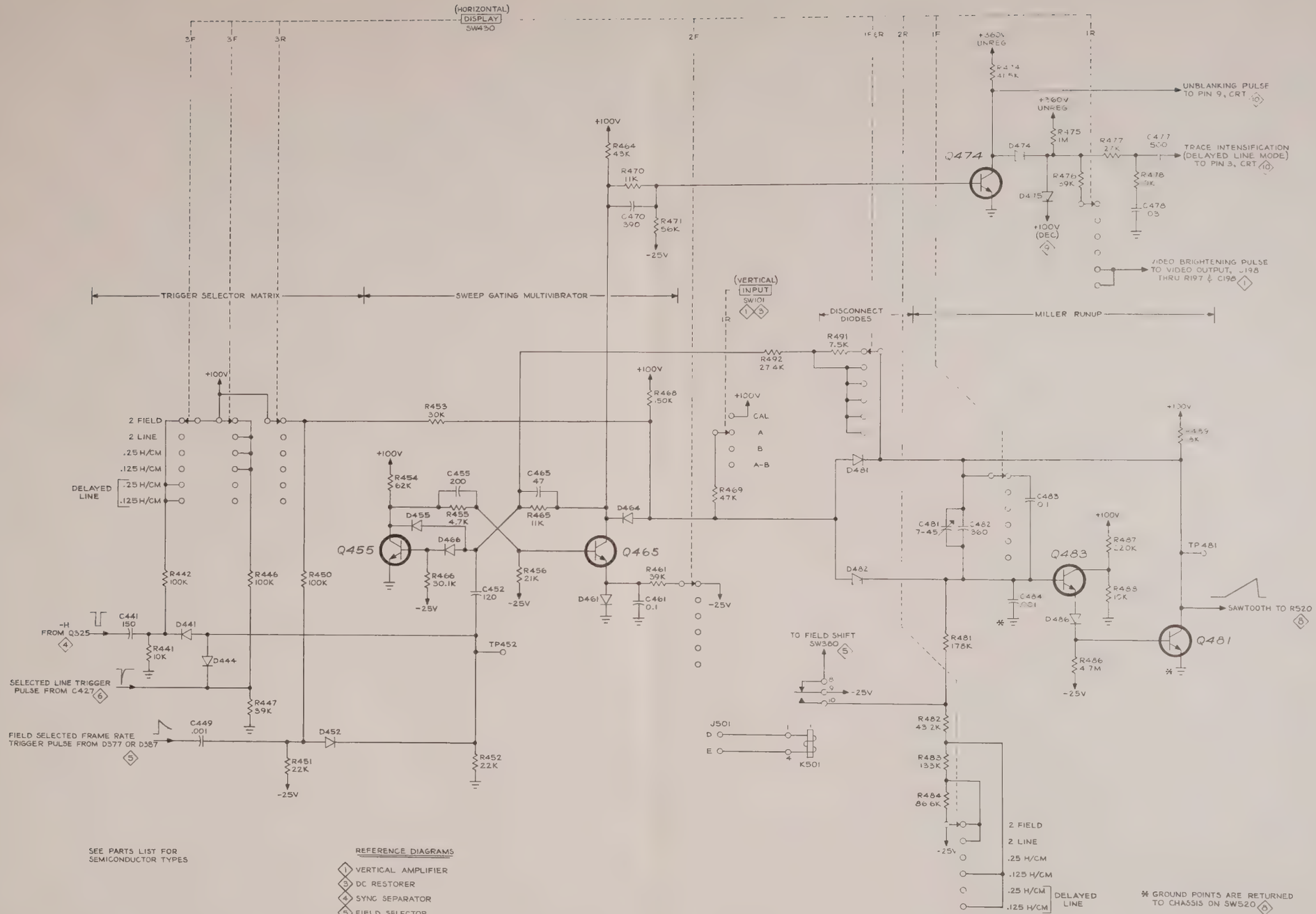


TYPE 529 WAVEFORM MONITOR

K

SWEEP GENERATOR 7

S/N 998 - 5999



SEE PARTS LIST FOR SEMICONDUCTOR TYPES

REFERENCE DIAGRAMS

1. VERTICAL AMPLIFIER
3. DC RESTORER
4. SYNC SEPARATOR
5. FIELD SELECTOR
6. LINE SELECTOR
8. HORIZONTAL AMPLIFIER
9. POWER SUPPLY
10. CRT CIRCUIT & CALIBRATOR

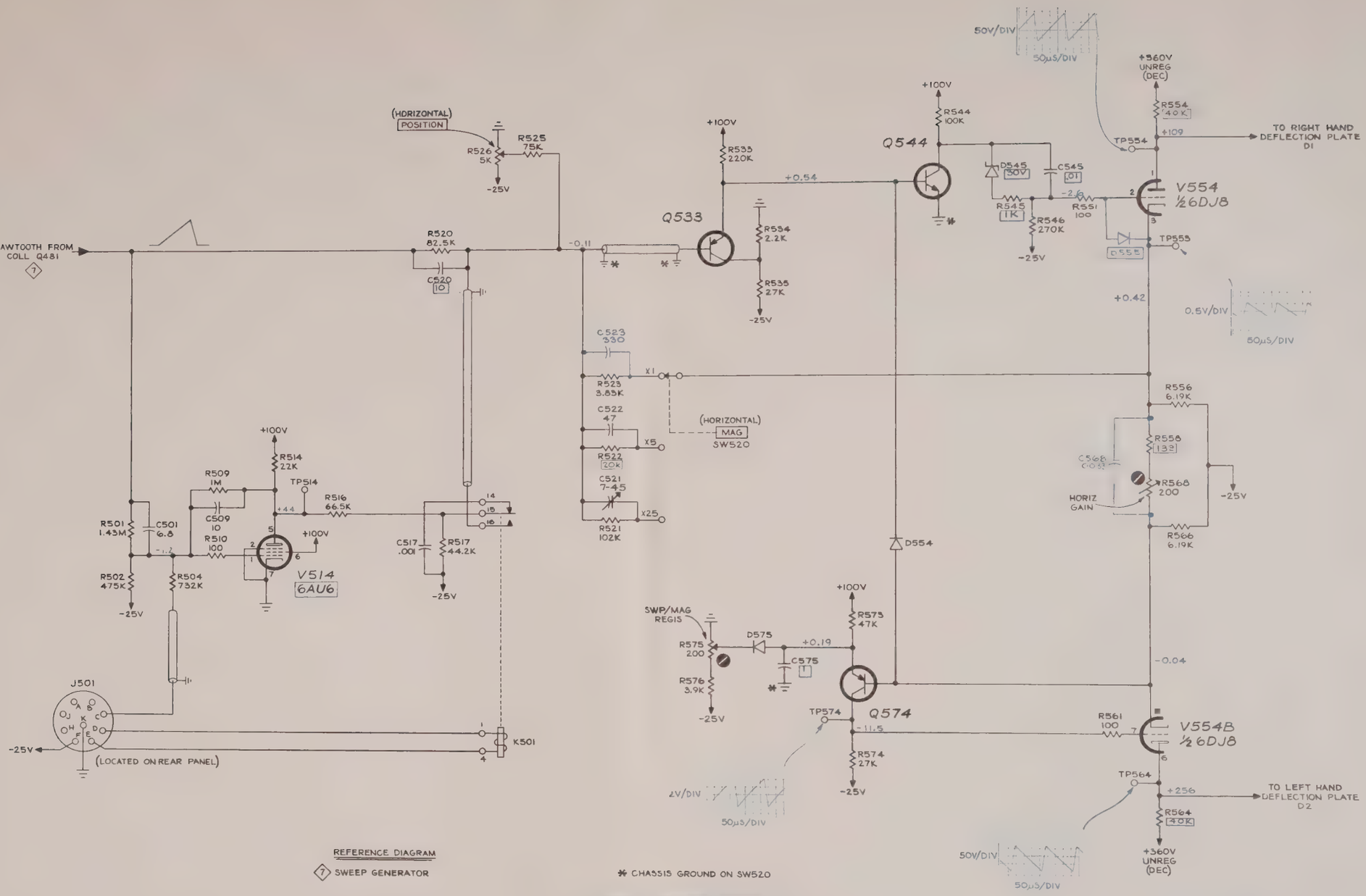
TYPE 529 WAVEFORM MONITOR

A

SN 965

SWEEP GENERATOR 7

S/N 101 - 997



REFERENCE DIAGRAM

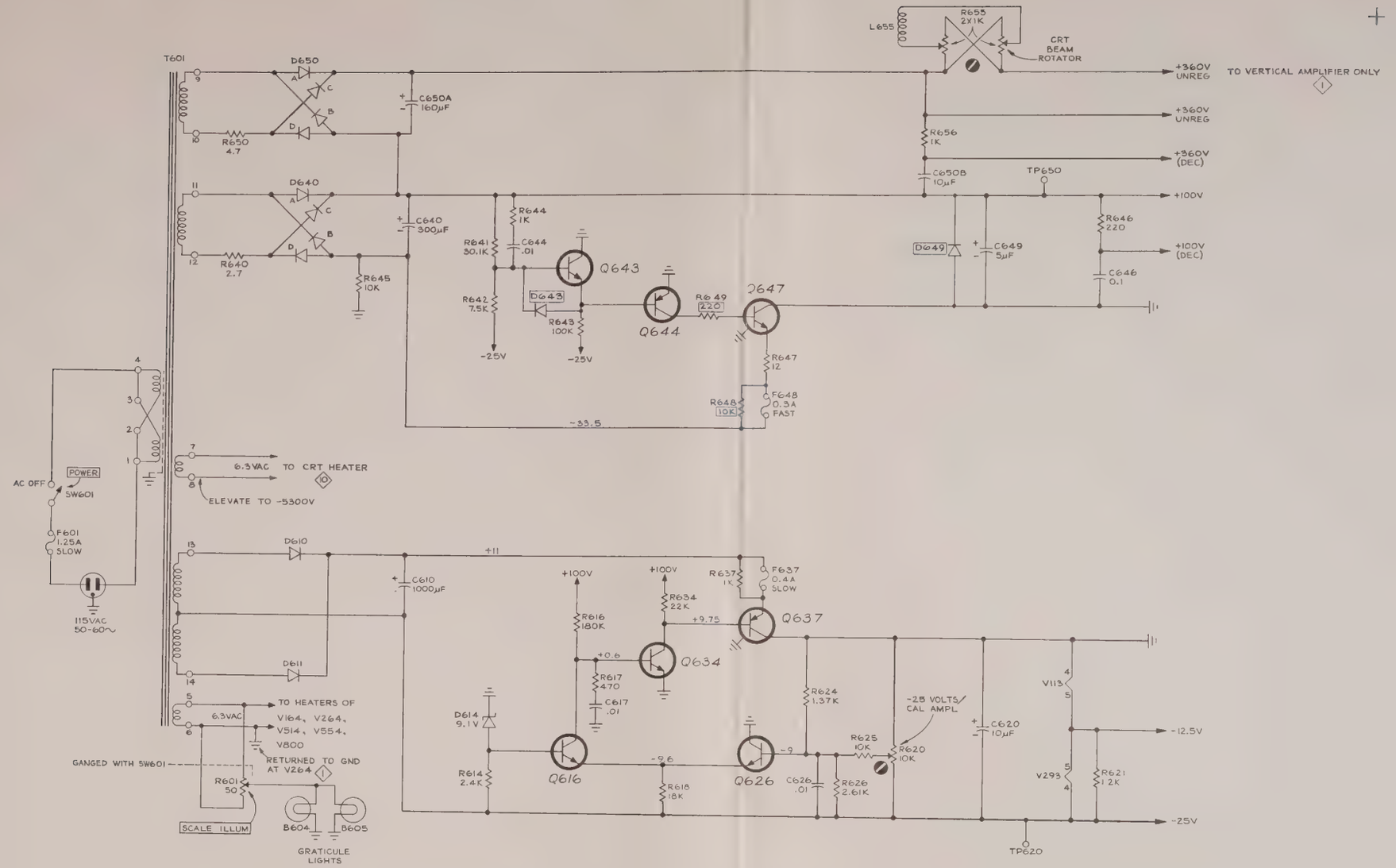
⑦ SWEEP GENERATOR

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

✱ CHASSIS GROUND ON SW520

VOLTAGES and WAVEFORMS obtained under conditions given on diagram ⑦

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.



VOLTAGES obtained under conditions given on diagram ⟨1⟩.

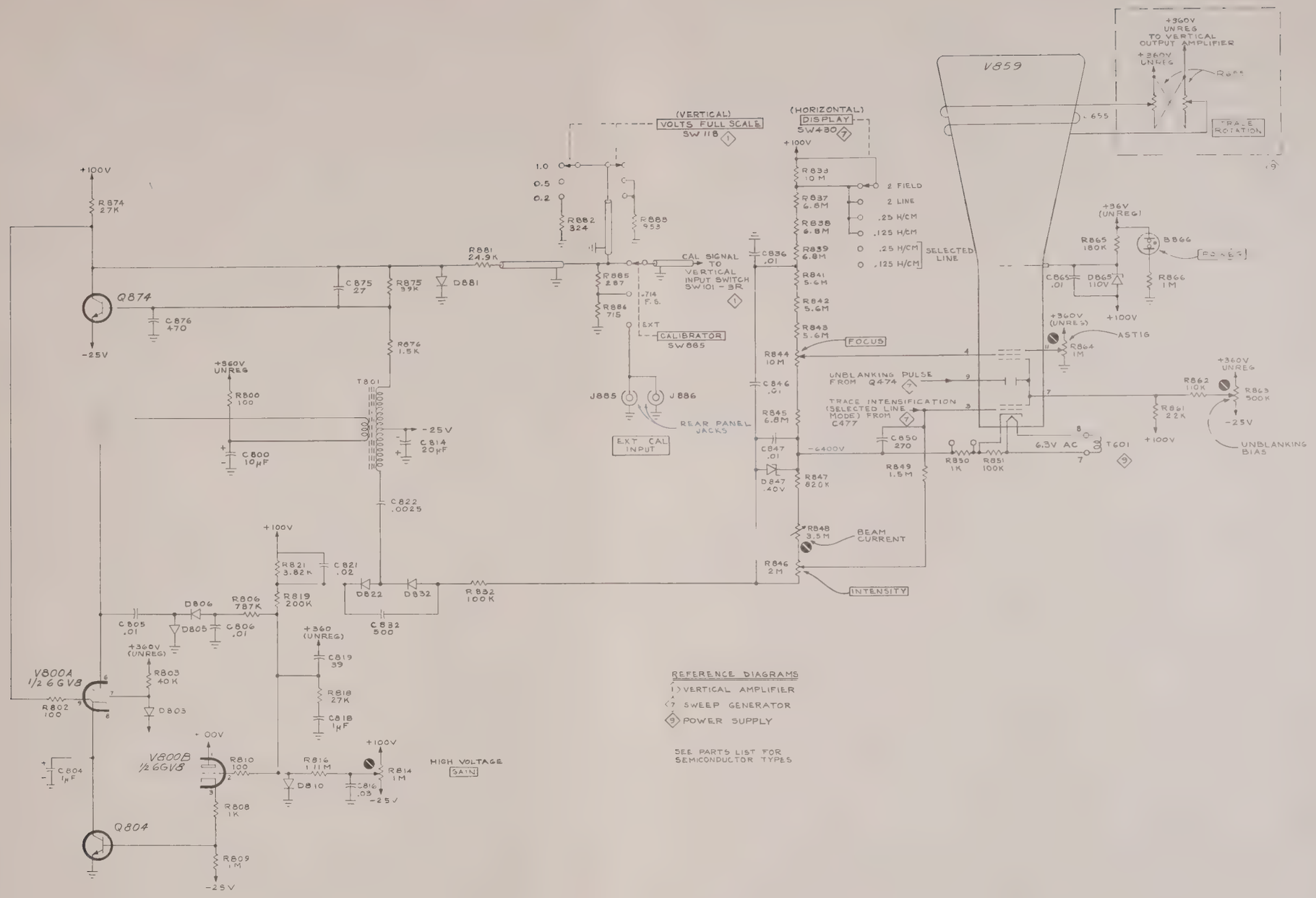
REFERENCE DIAGRAMS

⟨1⟩ VERTICAL AMPLIFIER

⟨10⟩ CRT & CALIBRATOR

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE

SEE PARTS LIST FOR SEMICONDUCTOR TYPES



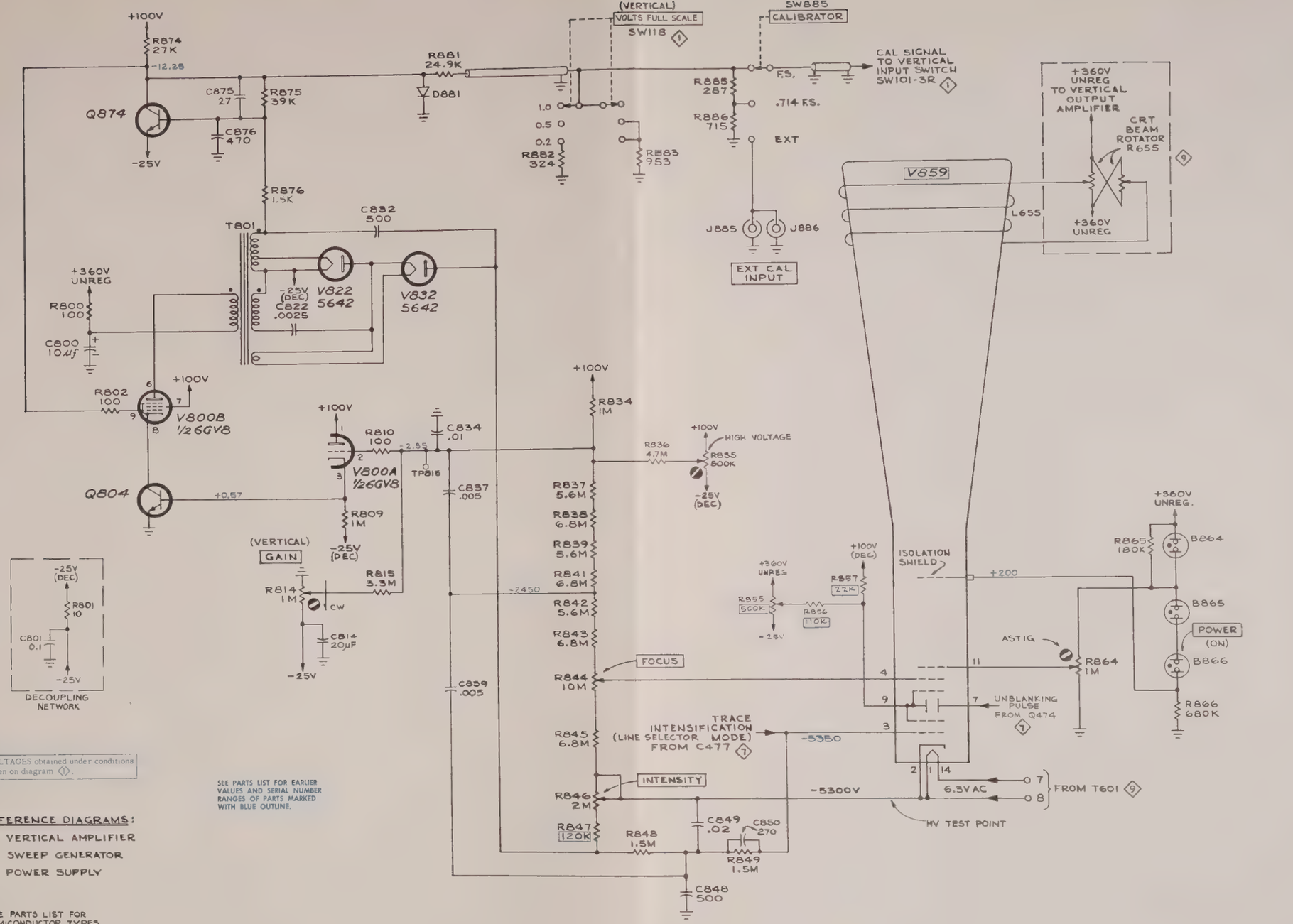
TYPE 529 WAVEFORM MONITOR

A1

768

CRT CIRCUIT & CALIBRATOR 10

S/N 6000-UP



VOLTAGES obtained under conditions given on diagram 1.

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

REFERENCE DIAGRAMS:

1 VERTICAL AMPLIFIER
7 SWEEP GENERATOR
9 POWER SUPPLY

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TYPE 529

ELECTRICAL PARTS LIST CORRECTION

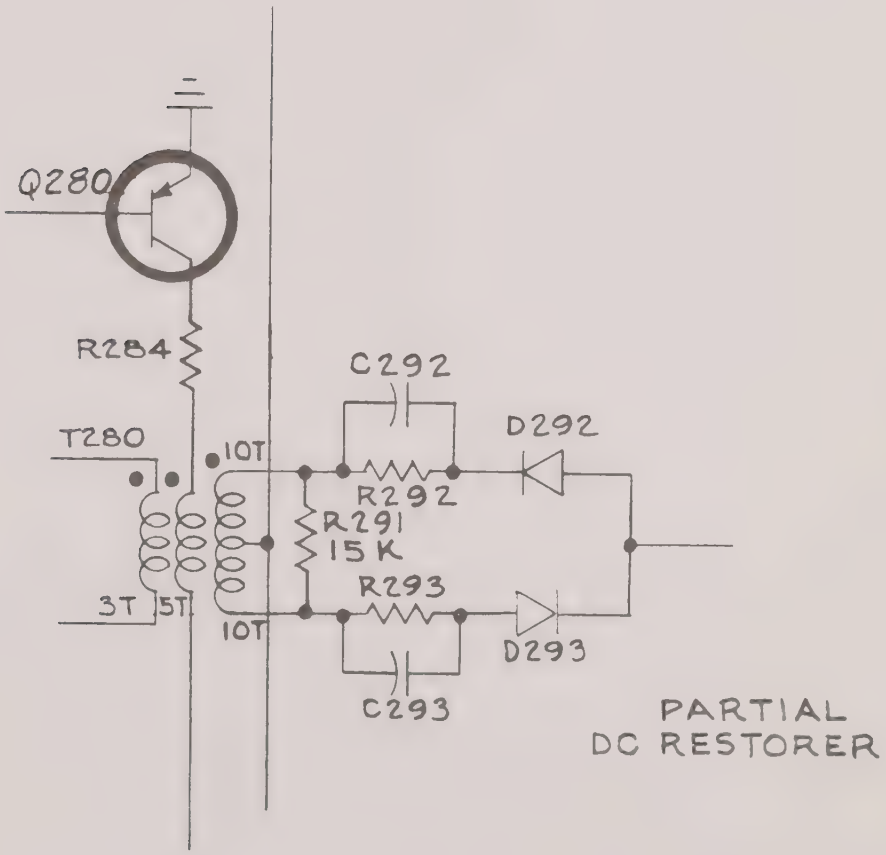
CHANGE TO:

R568	311-0004-00	200 Ω, Var		HORIZ GAIN

ADD:

R291	315-0153-00	15 kΩ	1/4 W	5%

SCHEMATIC CORRECTION



ADDENDUM TO M12,429/768

Page 27 of 30 Electrical Parts List Correction

ADD:

R161	308-0241-00	22 kΩ	7 W	WW	1%

TEXT CORRECTION

Section 2 Operating Instructions

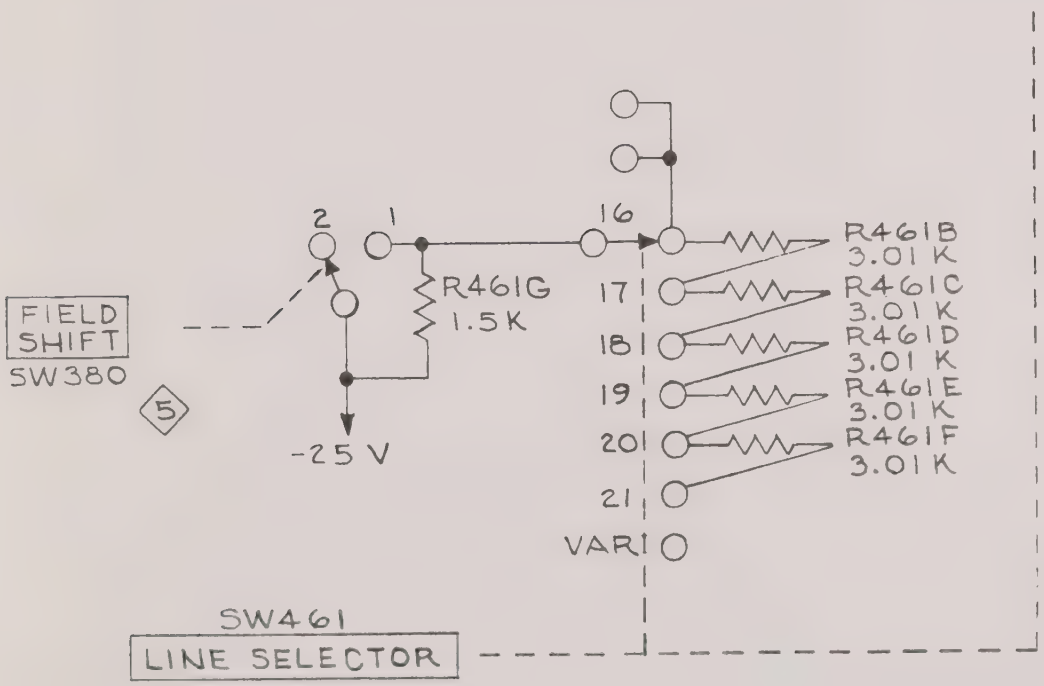
Page 2-2, VARIABLE (MAG)

CHANGE: "minimum range of 4 to 1" to read "minimum range of 2.5 to 1".

SCHEMATIC CORRECTIONS

Section 9 Diagrams

CHANGE: The Sweep Generator, S/N 6000-UP, diagram ⟨7⟩ as follows:



PARTIAL SWEEP GENERATOR ⟨7⟩

S/N 6000-UP

CHANGE: The Horizontal Amplifier diagram ◇8◇ to show circuit number D555 and its associated schematic lines in black instead of blue. The box drawn around circuit number D555 should remain in blue.

ADD: On the CRT Circuit & Calibrator diagram ◇10◇; D803 cathode should be shown connected to +100 V. The screen grid pin number for V800A is pin 7 and the cathode pin number for V800B is pin 3.

TYPE 529 TENT SN 6390

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

C805	283-0013-00	0.01 μF	Cer	1 kV

M14,687/1168

(Correction to
M12,429/768)

TEXT CORRECTION

Section 2 Operation Instructions

Page 2-5 CRT Beam Rotator

CHANGE: to read CRT TRACE ROTATION, and change all other references to CRT Beam Rotator to read CRT TRACE ROTATION.

Section 3 Circuit Description

Page 3-3 Constant Current Stage.

CHANGE: line twelve to read as follows:

The increased current pulls down on R121. R122 and R125 divides the

Page 3-3 Fig. 3-3

CHANGE: R122 to read "R122/R125"

Page 3-3 Response Filters, paragraph 5

CHANGE: to read as follows:

The HIGH PASS position of the RESPONSE switch inserts components making the overall monitor bandpass about 800 kHz centered at 3.58 MHz. The DC level at the input of the output amplifier is maintained by connecting the center (AC ground point) of L139 to the junction of R122 and R125.

Page 3-4 Output Amplifier (cont)

ADD: the following sentence to the first paragraph in the second column:

The screen grids of V164 and V264 are current limited by R161 and D161.

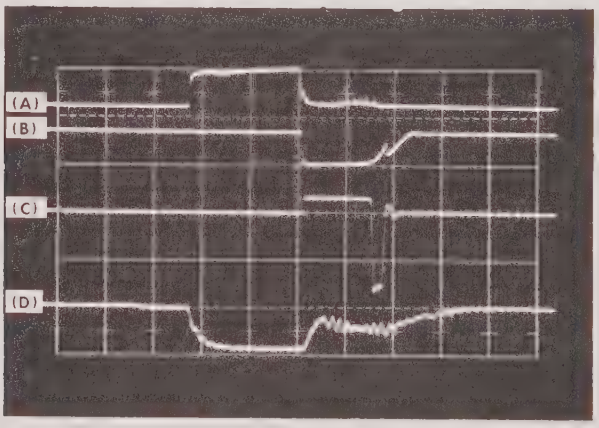
Page 3-5 Keyed DC Restorer

ADD: the following sentence to the second paragraph under Keyed DC Restorer:

Burst is removed from the output signal of the comparator by the filter action of L274, C274, and C275.

Page 3-5 Fig. 3-6

REPLACE: Fig. 3-6 with the following:



Page 3-6 Blocking Oscillator

CHANGE: the seventh line of the third paragraph to read as follows:

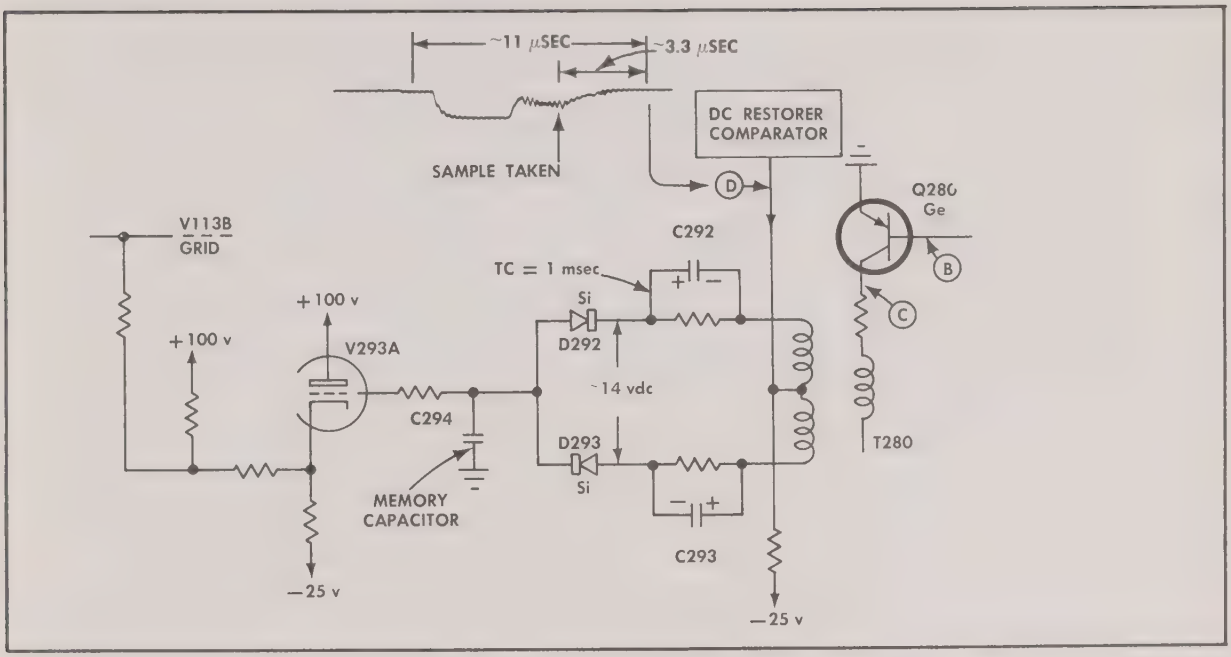
keeps Q280 conducting for about 3 µs before the base

Page 3-6 Memory Circuit

DELETE: all of the second paragraph following the first sentence.

Page 3-7 Fig. 3-8

REPLACE: Fig. 3-8 with the following:



Page 3-10 2 LINE DISPLAY.

ADD: the following sentence to the end of the last paragraph:

The time constant of C452 and R467 prevents Q455 from being pre-triggered by the equalizing pulses during the vertical interval time, while the sweep is running down.

Page 3-10 Miller Runup

CHANGE: the third and fourth sentences of the first paragraph to read as follows:

As Q483 gate starts negative, the base of Q481 also starts negative and reduces its collector current, causing its collector voltage to start positive. The timing capacitor couples the positive voltage of Q481 collector back to Q483 gate, essentially stopping its negative travel. The result

Page 3-11 Miller Runup (cont)

ADD: the following sentence to the end of the first paragraph:

The quiescent collector voltage of Q481 is primarily determined by the bias on Q483, a FET, and zener diode D469. The voltage drop across D469 insures that D482 is reverse biased during the runup time of the sweep.

Page 3-11 Column one, paragraph one

CHANGE: line five to read as follows:

raises the gate voltage of Q483 positive through D469 and D482. This

DELETE: the seventh sentence from this paragraph, it begins as follows:

(D486 offsets the base voltage.....

Page 3-16 CRT CIRCUIT AND CALIBRATOR

ADD: the following to the present heading:

"SN 100-5999"

ADD: the following text before the present CRT CIRCUIT AND CALIBRATOR SN 100-5999 text:

CRT CIRCUIT AND CALIBRATOR Serial 6000 and up

The high voltage for the CRT elements is supplied by a high voltage oscillator circuit consisting of V800A/B, Q804, and Q874. V800A is the oscillator tube and Q874 is the feedback transistor. Q874 also develops the CAL signal for calibrating the Type 529. V800B and Q804 control the current through V800A, thus controlling the amplitude of the oscillations. The high voltage necessary for operating the CRT is obtained from a voltage doubler circuit consisting of C822, C832, D822 and D832.

High Voltage Oscillator

When power is intially applied to the instrument, V800A is off because of its cold filaments. Q874 turns on first. As the filaments of V800 warm up, V800A starts to conduct, which causes current to flow through the primary of T801. As the current through the primary of T801 increases, a voltage is induced into the secondary, with the end connected to the base of Q874 being negative. A negative-going signal applied to the base of Q874 causes the transistor to decrease conduction, and its collector goes in the positive direction. The positive-going signal on the collector of Q874 is coupled to the grid of V800A, causing the tube to increase conduction. V800A continues to increase conduction until Q874 is turned off. When Q874 is turned off, the voltage at the grid of V800A is no longer changing; therefore, the current through the tube does not change. Since the current through the primary of T801 is determined by the conduction of V800A, the current through the primary is not changing and there is no voltage induced into the secondary winding. With no signal applied to the base of Q874, the transistor turns on again. As Q874 starts conducting, its collector goes in the negative direction. This negative-going signal is coupled to the grid of V800A, causing the tube to decrease conduction. The decrease of current flow through the primary of T801 induces a positive going voltage into the secondary, which is coupled to the base of Q874, causing the transistor to increase conduction. The current through V800A continues to decrease until Q874 is driven into saturation, at which time the cycle starts over again. The signal developed on the collector of Q874 swings

from approximately +0.6 V (which is set by D881) to approximately -25 V, established by the emitter voltage of Q874.

Voltage Doubler

As V800A is increasing conduction there is a positive-going voltage induced at the junction of T801 secondary and C822. This causes D832 to be reverse biased and D822 to become forward biased. Current now flows through R821, D822, and C822 to the -25 V supply. A charge is developed across C822 with the junction of T801 and C822 being positive. As V800A starts decreasing conduction, the polarity of the voltage induced into the secondary reverses, D822 is reverse biased and D832 becomes forward biased. The charge across C822 is in series with the voltage induced into the center-tapped secondary of T801; therefore, the charge developed across C832 is approximately two times the induced voltage, or approximately 7 kV.

High Voltage Regulator

The amplitude of the signal developed in the plate circuit of V800A is controlled by V800B and Q804, which control the current through V800A. The bias of V800B is set by the adjustment of R814, GAIN Adjust. This determines the current through V800B and the voltage developed in its cathode circuit. The base of Q804 is connected to the junction of R808, which limits the base current of Q804 and R809 in the cathode circuit of V800B. The conduction of V800B, therefore, determines the bias of Q804 which controls the current through V800A, the high voltage oscillator.

The conduction of V800B is also controlled by the voltage across R806, which is a sample of the amplitude of the signal developed in the plate circuit of V800A. As V800A is increasing conduction during the negative

half cycle of the signal developed in the plate circuit, the signal on the plate is coupled through C805, forward biasing D806 and charging C806. When V800A starts decreasing conduction and the charge on C806 becomes more negative than the signal on the plate of V800A, D806 is reverse biased. The discharge time of C806 is sufficiently long that C806 retains most of its charge during the remainder of the cycle. The positive excursion of the signal coupled through C805 is limited to approximately +0.6 V by D805 at the cathode end of D806. C806 charges to the peak amplitude of the signal developed in the plate circuit of V800A and the voltage across R806 establishes the bias voltage of V800B. Assume that the amplitude of the signal developed by the oscillator increases. This causes the charge on C806 to become more negative. The voltage at the grid of V800B becomes more negative, decreasing the conduction of V800B, causing its cathode voltage to become more negative. The voltage at the base of Q804 becomes more negative, decreasing the current flow through the transistor and returning the amplitude of the oscillator signal to the correct amplitude.

Any current changes occurring in the CRT circuit will produce a current change through R821. The current change through R821 will cause the voltage level at the grid of V800B to change and the regulator circuit will react to compensate for this change.

The positive level at the grid of V800B is limited to +0.6 V by D810. R818/C818 is a frequency-compensating network and C819 is a filter for 120 cycle ripple. The screen grid of V800A is clamped at +100 V by D803. If the oscillator tube tries to draw excessive current, the voltage drop across R803 will increase, reducing the screen voltage and limiting the current.

CRT Circuit

The high voltage developed by the voltage doubler is applied to a divider which provides the correct operating potential for the cathode, control grid, and focusing anode of the CRT. The voltage drop across R846, R847, and R848 is maintained at a fixed value by zener diode D847. This insures that the supply voltage to the CRT cathode will remain at a constant level regardless of any current changes through the divider. C850 filters out any voltage ripple between the CRT grid and cathode which would intensity-modulate the CRT trace. The CRT cathode current can be checked by measuring the voltage across R850. The voltage should typically be 0.15 volts, which indicates the current to be 150 μA (plus meter current). The voltage across R850 is set by the adjustment of Beam Current, R848.

In the SELECTED LINE modes of the DISPLAY switch, a trace intensification pulse is coupled to the CRT grid. To prevent any de-focusing that might occur, R833 is added to the divider. This increases the negative voltage at the focusing anode to maintain the same voltage relationship between the control grid and focusing anode; thereby keeping the trace in focus. R833 is shorted out in the other modes of the DISPLAY switch.

CRT Control Circuits

The INTENSITY CONTROL adjusts the DC potential of the control grid, thus controlling the quantity of electrons in the electron beam.

Focus of the CRT display is controlled by the FOCUS control, R844. The voltage applied to the focus grid is more positive (less negative) than the voltage on either the control grid or the CRT cathode. The ASTIG adjustment, R864, which is used in conjunction with the FOCUS control to provide a well-defined display, varies the positive level on the astigmatism grid.

The Unblanking Bias adjustment, R863, changes the difference of potential between the unblanking plates and is adjusted for uniform intensity on the CRT.

The TRACE ROTATION adjustment controls the current through L655, which rotates the beam in order to align the trace with the graticule.

Calibrator

The Square wave that is developed in the collector circuit of Q874 swings between approximately +0.6 V (set by D881) and -25 V (set by the emitter voltage of Q874) and is used as the calibrator signal. When the VOLTS FULL SCALE switch is in the 1.0 position, the 25 V signal is divided by R881, R885 and R886 for use in the vertical amplifier. When the VOLTS FULL SCALE switch is in either the 0.5 or 0.2 position, the gain of the vertical amplifier is increased and R883 or R883 and R882 is added to the divider to reduce the amplitude of the Cal Signal to maintain the display on screen. The .714 F. S. position of the CALIBRATOR switch changes the point in the divider at which the output is taken off, thereby reducing the amplitude of the Cal Signal out.

With the CALIBRATOR switch in the EXT position, the external calibrator input impedance is 1 megohm.

Section 4 Maintenance

Page 4-3 Cathode-Ray Tube, WARNING

CHANGE: the WARNING to read as follows:

WARNING

High vacuum cathode ray tubes are dangerous to handle. To prevent personal injury from flying

glass in case of tube breakage, wear a face mask or safety goggles, and gloves.

Handle the CRT with extreme care. Do not strike or scratch it. Never subject it to more than moderate force or pressure when removing or installing.

Always store spare CRT's in original protective cartons. Save cartons to dispose of used CRT's.

Section 5 Performance Check

Page 5-2

CHANGE: 2. Check Crt Beam Rotator and Horizontal Geometry to read: "2. Check CRT TRACE ROTATION and Horizontal Geometry".

Page 5-2 Step 2, NOTE

CHANGE: the last sentence of the NOTE to read as follows:

If the traces are not parallel to the horizontal graticule line, it will be necessary to adjust the front panel CRT TRACE ROTATION control until the trace is parallel to the horizontal graticule lines.

Section 6 Calibration

Page 6-1 Special Test Equipment

CHANGE: Item 1 to read as follows:

1. DC voltmeter. Minimum sensitivity, 20,000 ohms/volt; accuracy, checked to within 1% at 25 and 100 volts, and checked to within 3% at 6400 volts. For example, Triplett Model 630 NA with high voltage probe.

Page 6-3 CALIBRATION RECORD AND INDEX

CHANGE: Step 3 to read as follows:

3. Adjust GAIN (High Voltage) R814. Serial 6000 and up.

-6400 volts

Adjust High Voltage (R835). Serial 100 through 5999 inclusive.

-5300 volts

CHANGE: Step 4 to read as follows:

4. Adjust CRT Beam Current (R848). Serial 6000 and up.

0.15 volts (150 µA) across R850.

Page 6-4 Step 31

CHANGE: Step 31 to read as follows:

31. Adjust Vertical Amplifier Chroma Frequency Response (L138, L238 and C239). Serial 6000 and up.

Adjust C239 for maximum amplitude at 3.58 MHz. Adjust L138 and L238 for 100 IEEE units.

Adjust Vertical Amplifier Chroma Frequemcy Response (T135). Serial 100 through 5999 inclusive. Set bottom transformer slug for 100 IEEE units of deflection at 3.58 MHz.

Set top transformer slug for 70 to 85 IEEE units of deflection at 3.18 MHz.

Check for 70 to 85 IEEE units of deflection at 3.98 MHz.

ADD: the following step after Step 31:

32. Adjust Vertical Amplifier Low Pass Filter. Serial 6000 and up.

Adjust L135, L235, L134, L234, L133, L233, and C232 for best square corner on leading edge of the cal signal waveform.

CHANGE: the step numbers of the existing steps 32 through 34 by one.

Page 6-8 Step 3

REPLACE: the existing Step 3 with the following:

3. Adjust GAIN (High Voltage), R814. Serial 6000 and up.

a. Test equipment required is shown in Fig. 6-4.

b. Remove the shield from the high voltage section of the instrument.

c. Set the DC voltmeter to measure approxiamtely negative 6400 volts (use the instruction manual for the voltmeter as a guide); connect the voltmeter between the junction of R845/R850 (see Fig. 6-5) and ground.

d. CHECK for a meter reading of -6400 volts.

e. ADJUST the GAIN control (R814), screwdriver adjustment located on the front panel, for a meter reading of 6400 volts.

f. Interaction may affect operation of all circuits.

g. CHECK High Voltage regulation.

h. Vary the autotransformer so the line voltage is set 10% above design center and hold for 1 minute at this extreme. Check that the high voltage remains essentially constant (within ±3% or 192 volts of the -6400 volt reading).

i. Vary the autotransformer so the line voltage is set 10% below design center and hold 1 minute at this extreme.

Check that the high voltage remains essentially constant (within ±3% or 192 volts of the -6400 volt reading).

j. Set the autotransformer for design center line voltage and disconnect the voltmeter.

Adjust HIGH VOLTAGE (R835) Serial No. 100 to 5999 inclusive.

a. Test equipment required is shown in Fig. 6-4.

b. Connect the DC voltmeter between the center arm of the INTENSITY control and ground.

c. Rotate the GAIN control from one extreme to the other.

d. CHECK that the meter reading varies.

e. Set the GAIN control to its midrange position.

f. CHECK for a meter reading of -5300 V.

g. Adjust the High Voltage control to obtain a meter reading of -5300 V.

h. Interaction - May affect operation of all circuit.

Perform steps f through i of adjust for Serial number 6000-up.

Page 6-8 Step 4

REPLACE: the existing Step 4 with the following:

4. Adjust CRT Beam Current (R848). Serial 6000 and up.

CAUTION

While performing the following parts of this step each meter lead will be elevated approximately 6400 volts with respect to ground.

a. Test equipment required is shown in Fig. 6-4.

b. Connect the DC voltmeter across R850 using the junction of R850/R845 as one test point and the CRT cathode end of R850 as the other test point (see Fig. 6-5). The junction of R845/R850 is the most negative.

c. Rotate the Type 529 INTENSITY control fully clockwise.

d. CHECK for a meter reading of 0.15 volts.

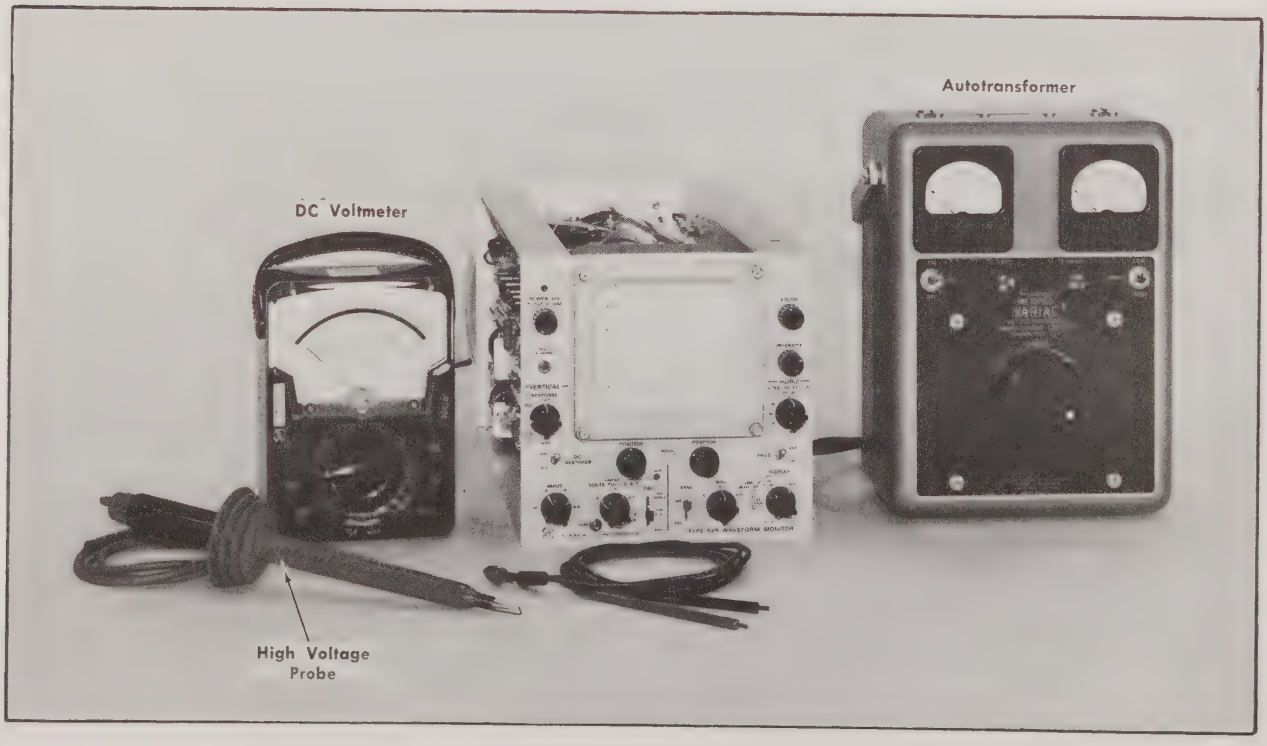
e. ADJUST R848 Beam Current Adjust (see Fig. 6-6) for a meter reading of 0.15 volts (150 µA).

f. Disconnect the DC voltmeter.

g. Replace the High Voltage shield.

Page 6-8 Fig. 6-4

REPLACE: Fig. 6-4 with the following figure:



Page 6-9 Step 5

REPLACE: part c with the following:

c. Adjust the FOCUS and ASTIG controls (R864; see Fig. 6-7) to obtain a well-defined display using normal brightness.

Page 6-9 Step 6

CHANGE: the words BEAM ROTATOR to read "TRACE ROTATION".

REPLACE: part c with the following:

c. Adjust the CRT TRACE ROTATION control (R655, screwdriver adjustment located on the front panel) so the flat bottom of the calibrator square waves coincides with the graticule line.

Page 6-9

REPLACE: Figures 6-5 and 6-7 with the following, (changing Fig. 6-7 cutline to read "Fig. 6-6. Location of CRT Beam Current adjustment (R848)."). Change the existing Fig. 6-6 to read "Fig. 6-7. Location of ASTIG adjustment."

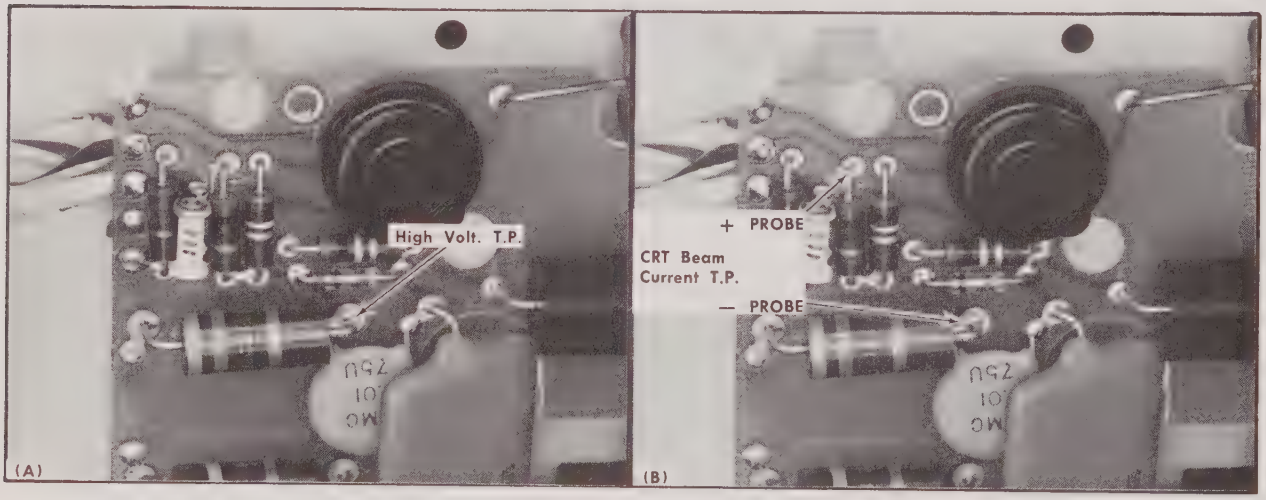


Fig. 6-5. (A) Location of high-voltage test point, (B) Test points for adjusting CRT Beam Current.

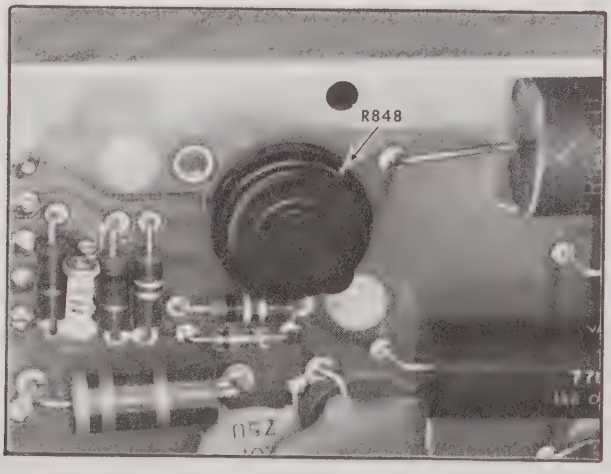


Fig. 6-6. Location of CRT Beam Current adjustment (R848).

Page 6-22 VERTICAL Controls

CHANGE:

VARIABLE (VOLTS FULL SCALE)	CALIB

ADD:

CAL	.714 FS

Page 6-25 Step 31

REPLACE: the existing Step 31 with the following:

31. Adjust Vertical-Amplifier Chroma Frequency Response

Serial 6000 and up.

a. Test equipment setup is given in step 26.

b. Set the REPONSE switch to FLAT, the VOLTS FULL SCALE switch to 1.0, and the INPUT switch to A.

c. Set the constant amplitude sine wave generator for an output frequency of 3.58 MHz and the output amplitude to 100 IEEE units.

d. Set the RESPONSE switch to HIGH PASS.

e. CHECK for 100 IEEE units of vertical deflection.

f. Adjust C239 (see Fig. 6-36) for maximum vertical deflection. Alternately adjust L138 and L238 (see Fig. 6-36) for 100 IEEE units of vertical deflection. The powdered iron cores of L138 and L238 should be maintained in the same relative position to each other.

g. Set the constant amplitude sine wave generator for an output frequency of 3.18 MHz.

h. CHECK for 65 to 85 IEEE units of vertical deflection.

i. Set the constant amplitude sine wave generator for an output frequency of 3.98 MHz.

j. CHECK for 65 to 85 IEEE units of vertical deflection. If necessary, readjust L138 and L238 to obtain the proper frequency response characteristics.

k. Disconnect the constant amplitude sine wave generator from the Type 529.

Adjust Vertical-Amplifier Chroma Frequency Response (T135) Serial 100 to 5999 inclusive.

a. Test equipment setup is given in step 26.

b. Set the RESPONSE switch to FLAT and VOLTS FULL SCALE switch to 1.0.

c. Set the constant-amplitude sine wave generator for 100 IEEE units of reference amplitude at 3.58 MHz.

d. Set the RESPONSE switch to HIGH PASS.

e. Check for 100 IEEE units of vertical deflection.

f. Adjust the bottom powder-iron slug in T135 to obtain 100 IEEE units of vertical deflection.

g. Set the constant-amplitude sine wave generator for an output frequency of 3.18 MHz.

h. Check for 65 to 85 IEEE units of vertical deflection.

i. Adjust the top slug in T135 to obtain 65 to 85 IEEE units of vertical deflection.

j. Set the constant-amplitude sine-wave generator for an output frequency of 3.98 MHz.

l. Check that the vertical deflection of the display is 65 to 85 IEEE units in amplitude. If necessary, repeat steps c through j to obtain proper frequency response characteristics.

m. After completing the adjustment of T135 and the checks in Table 6-2, disconnect the constant-amplitude sine-wave generator from the Type 529.

ADD: the following step:

32. Adjust Vertical Amplifier Low Pass Filter. Serial No. 6000 and up.

a. Test equipment required is shown in Fig. 6-37.

b. Set the RESPONSE switch to LOW PASS and the INPUT switch to CAL.

c. CHECK for good square corner on leading edge of the cal signal waveform.

d. ADJUST in the following sequence, L135, L235, L134, L234, L133, L233 and C232 (see Fig. 6-38) for best square corner on leading edge of cal signal waveform.

Page 6-25 Fig. 6-36

REPLACE: Fig. 6-36 with the following:

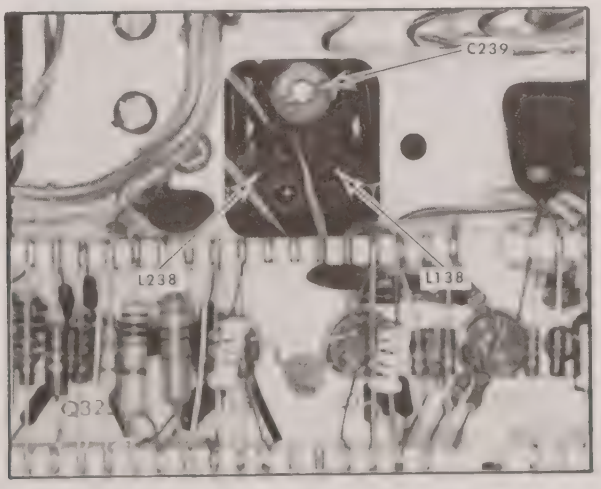


Fig. 6-36. Location of L138, L238 and C239.

Page 6-25

ADD: the following Fig. 6-37:

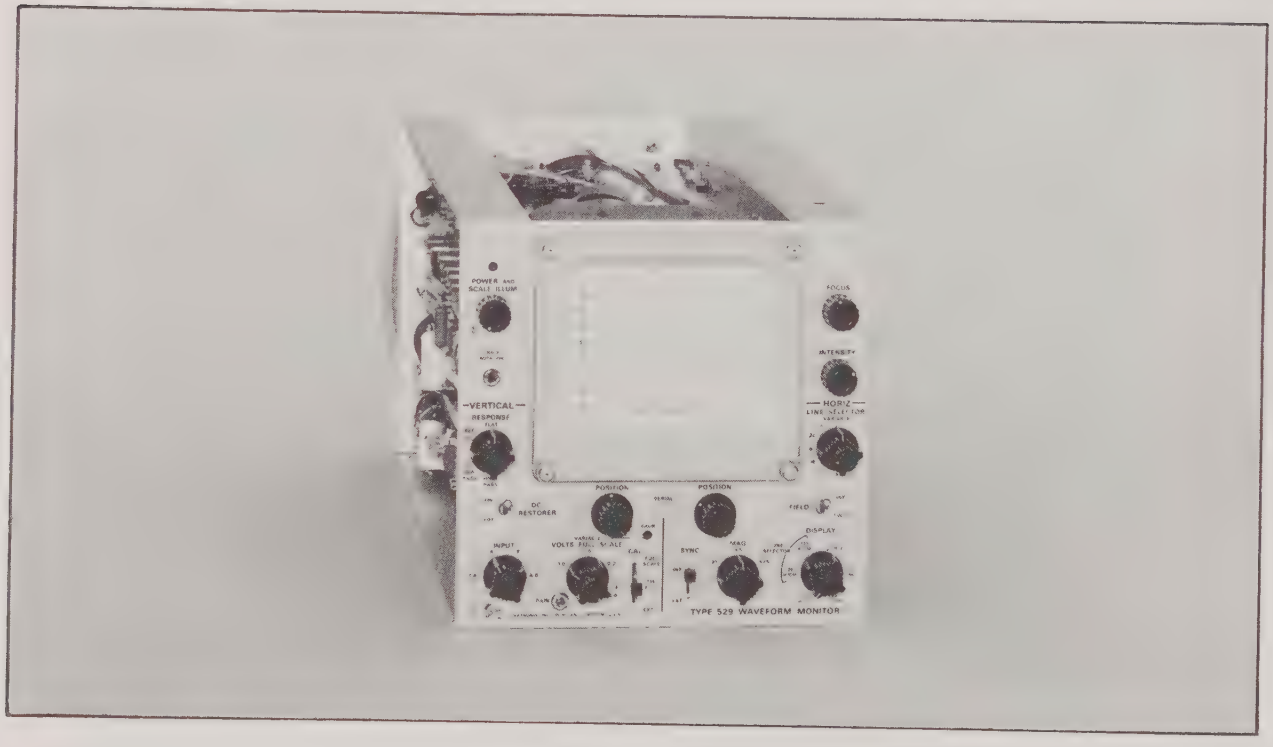


Fig. 6-37. Test equipment setup for step 32.

Page 6-25

ADD: the following Fig. 6-38:

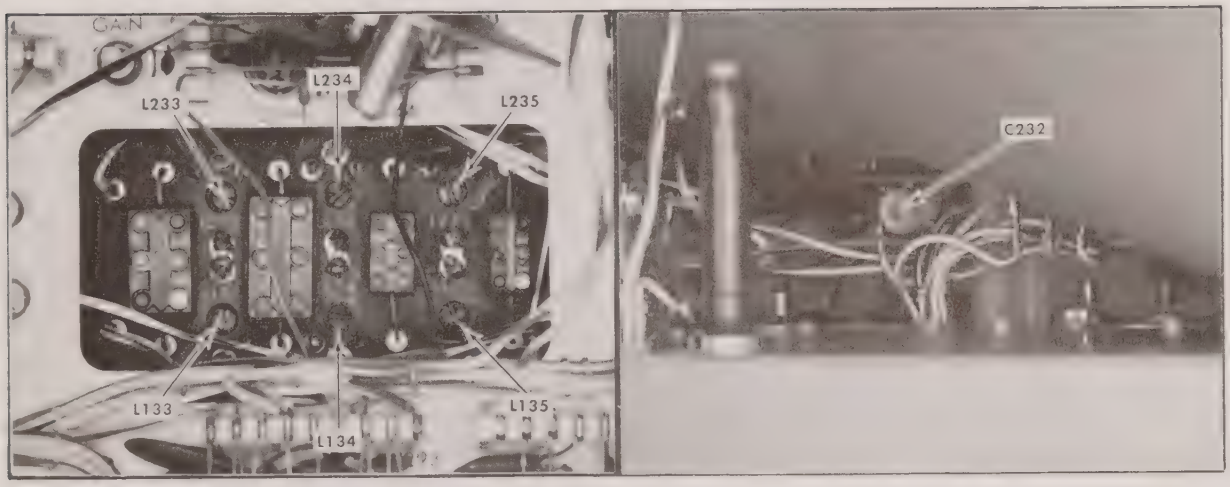


Fig. 6-38. Location of L135, L235, L134, L234, L133, L233 and C232. Coil adjusting screws are accessible through the wafers of the DISPLAY switch.

Page 6-26 Fig. 6-37

CHANGE: Fig. 6-37 to read "Fig. 6-39", and change all succeeding figure numbers and their references by two numbers.

Page 6-26 Step 32A

CHANGE: Step 32A to read "Step 33A", and change all succeeding steps and their references by one number.

ELECTRICAL PARTS LIST CORRECTION

REMOVE:

B864	150-0030-00	Neon, NE-2V			
B865	150-0030-00	Neon, NE-2V			
C134	281-0511-00	22 pF (nominal value)	Selected		
C135	281-0620-00	21 pF	Cer	500 V	1%
C139	283-0594-00	0.001 µF	Mica	100 V	1%
C165	283-0001-00	0.005 µF	Cer	500 V	
C265	283-0001-00	0.005 µF	Cer	500 V	
C801	283-0111-00	0.1 µF	Cer	50 V	
C834	285-0622-00	0.1 µF	PTM	100 V	
C837	283-0034-00	0.005 µF	Cer	4000 V	
C839	283-0034-00	0.005 µF	Cer	4000 V	
C848	283-0096-01	500 pF	Cer	20000 V	
C849	283-0006-00	0.02 µF	Cer	500 V	
D486	152-0185-00	Silicon	Replaceable by 1N4152		
L139	108-0214-00	400 µH			
L239	108-0214-00	400 µH			
R135	321-0279-00	7.87 kΩ	1/8 W	Prec	1%
R283	316-0151-00	150 Ω	1/4 W		
R801	302-0100-00	10 Ω	1/2 W		
R815	316-0335-00	3.3 MΩ	1/4 W		
R819	321-0414-00	200 kΩ	1/8 W	Prec	1%
R834	315-0105-00	1 MΩ	1/4 W		5%

REMOVE (cont):

R835	311-0183-00	500 kΩ,Var	HIGH VOLTAGE
R836	316-0475-00	4.7 MΩ	1/4 W
T135	120-0362-00	RF 3.58 MHz	Center frequency
V822	154-0051-00	5642	
V832	154-0051-00	5642	

CHANGE TO:

C122	283-0004-00	0.02 µF	Cer	150 V	
C133	283-0533-00	39 pF		500 V	5%
C478	283-0002-00	0.01 µF	Cer	500 V	+80%-20%
C484	283-0001-00	0.005 µF	Cer	500 V	
D282	152-0185-00	Silicon	Replaceable by 1N4152		
D464	152-0185-00	Silicon	Replaceable by 1N4152		
D482	152-0249-00	Silicon			
Q280	151-0188-00	2N3906			
Q483	151-1022-00	FET			
R122	321-0173-00	619 Ω	1/8 W	Prec	1%
R160	308-0055-00	1.5 kΩ	10 W	WW	
R280	321-0300-00	13.0 kΩ	1/8 W	Prec	1%
R281	321-0273-00	6.81 kΩ	1/8 W	Prec	1%
R284	315-0150-00	15 Ω	1/4 W		5%

CHANGE TO (cont):

R468	323-0335-00	30.1 kΩ	1/2 W		1%
R478	315-0223-00	22 kΩ	1/4 W		5%
R481	321-0404-00	158 kΩ	1/8 W	Prec	1%
R482	321-0345-00	38.3 kΩ	1/8 W	Prec	1%
R483	321-0392-00	118 kΩ	1/8 W	Prec	1%
R484	321-0375-00	78.7 kΩ	1/8 W	Prec	1%
R486	315-0822-00	8.2 kΩ	1/4 W		5%
R487	301-0203-00	20 kΩ	1/2 W		5%
R492	321-0328-00	25.5 kΩ	1/8 W	Prec	1%
R558	322-0648-00	133 Ω	1/4 W		0.5%
R814	311-0252-00	1 MΩ,Var	1/4 W		
R837	305-0685-00	6.8 MΩ	2 W		5%
R838	305-0685-00	6.8 MΩ	2 W		5%
R839	305-0685-00	6.8 MΩ	2 W		5%
R841	305-0565-00	5.6 MΩ	2 W		5%
R842	305-0565-00	5.6 MΩ	2 W		5%
R845	305-0685-00	6.8 MΩ	2 W		5%
R847	302-0824-00	820 kΩ	1/2 W		
R848	311-0174-00	3.5 MΩ, Var		1/2 W	

SW118	262-0753-02	Rotary	VOLTS FULL SCALE
SW135	262-0686-02	Rotary	VERTICAL RESPONSE
SW430	262-0688-02	Rotary	HORIZONTAL DISPLAY

CHANGE TO (cont):

T280	120-0574-00	Toroid			
T801	120-0572-00	High Voltage			

ADD:

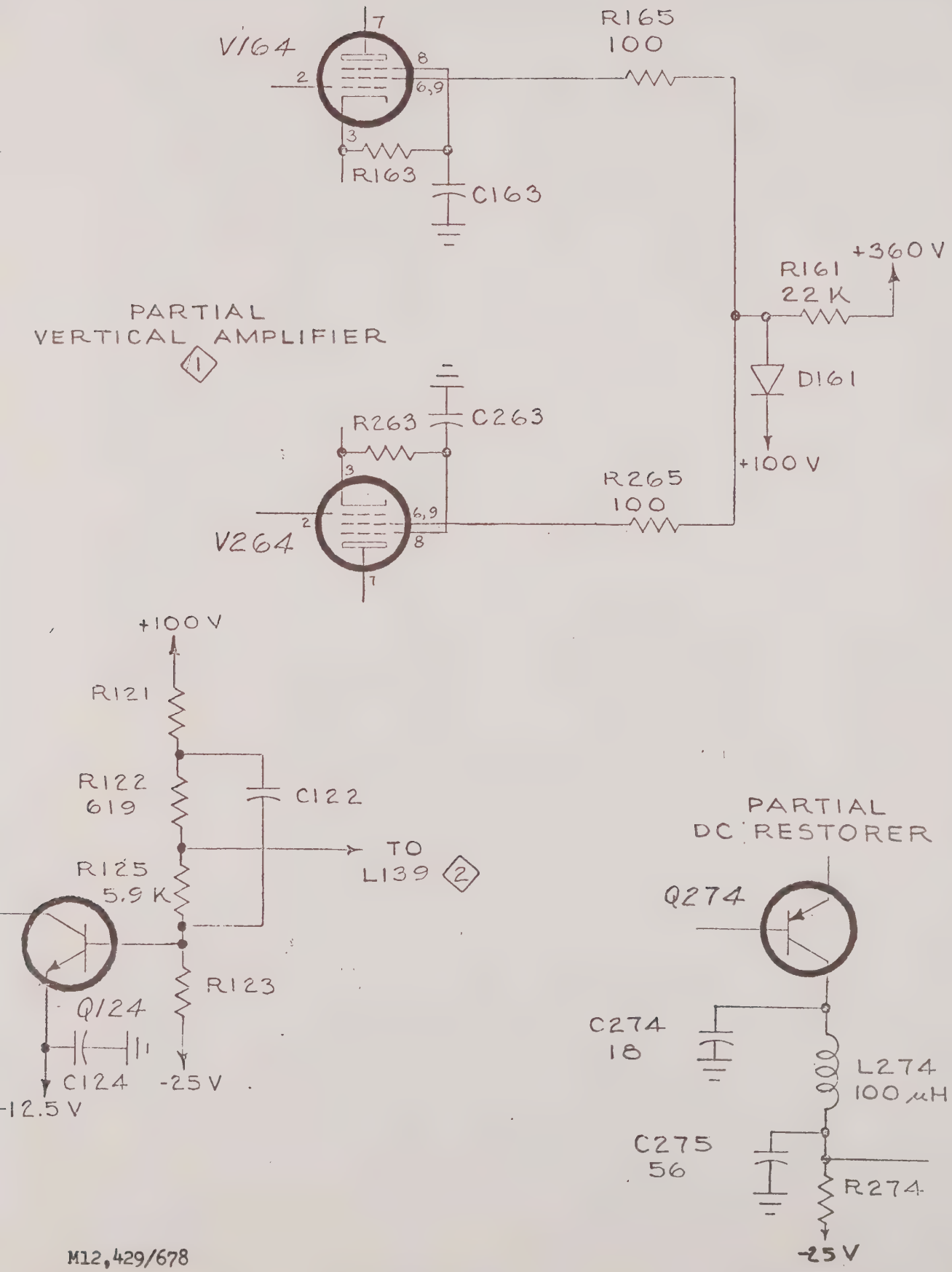
C131	285-0622-00	0.1 µF	PTM	100 V	
C132	281-0599-00	1 pF		200 V	
C134	283-0652-00	150 pF			1%
C135	283-0620-00	470 pF		300 V	1%
C138	283-0635-00	51 pF		100 V	1%
C139	283-0599-00	98 pF		500 V	5%
C232	281-0097-00	9-35 pF, Var			
C233	283-0552-00	200 pF		500 V	1%
C234	283-0654-00	790 pF			1%
C235	283-0620-00	470 pF		300 V	1%
C238	283-0635-00	51 pF		100 V	1%
C239	281-0092-00	9-35 pF, Var			
C274	281-0578-00	18 pF		500 V	
C275	283-0113-00	56 pF		500 V	
C469	283-0026-00	0.2 µF		25 V	
C804	290-0183-00	1 µF		35 V	
C805	283-0002-00	0.01 µF		500 V	
C806	283-0002-00	0.01 µF		500 V	
C816	283-0092-00	0.03 µF		200 V	
C818	283-0059-00	1 µF		25 V	
C819	281-0562-00	39 pF		500 V	
C821	283-0004-00	0.02 µF		150 V	

ADD (cont):

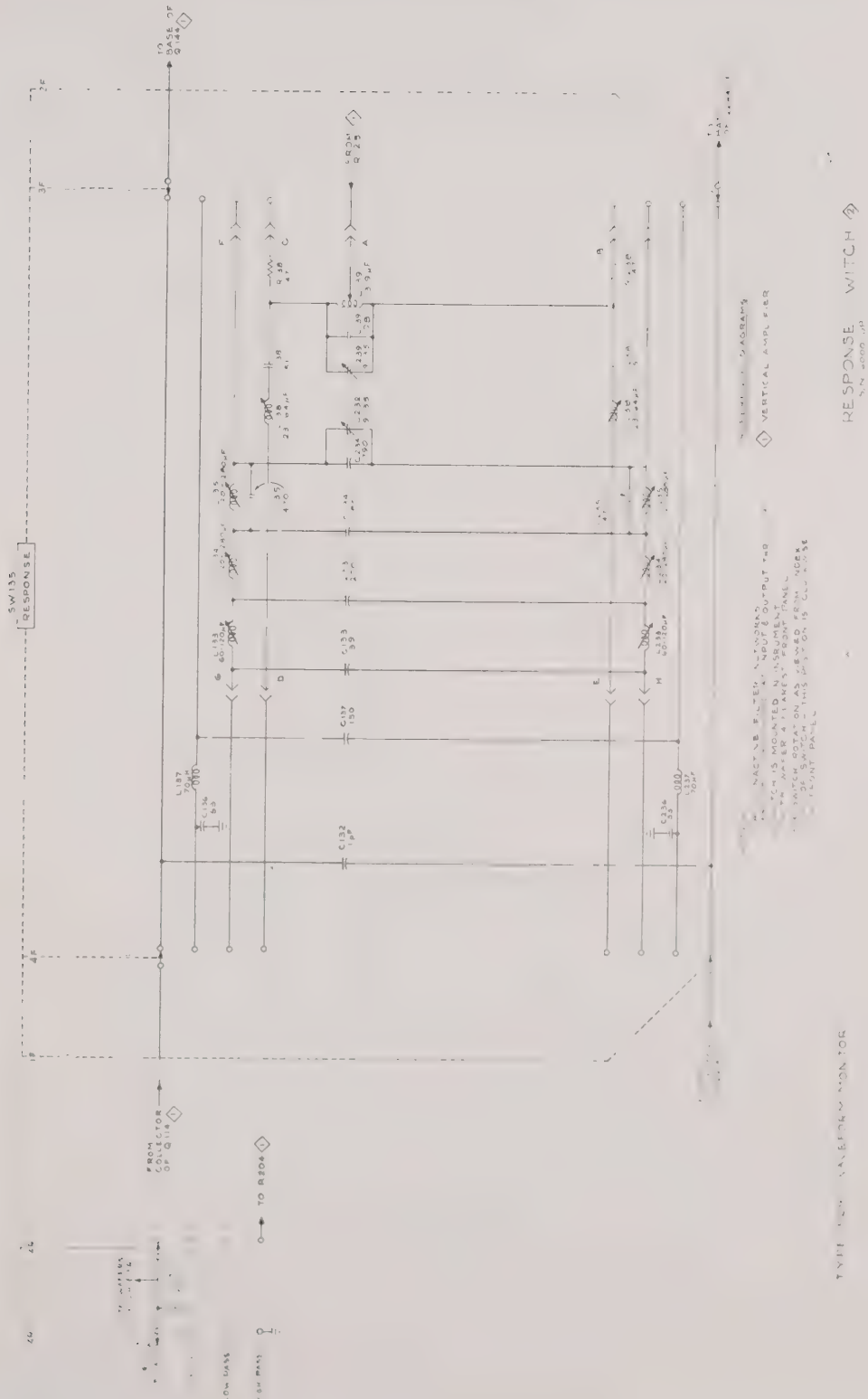
C836	283-0082-00	0.01 µF		4000 V
C846	283-0082-00	0.01 µF		4000 V
C847	283-0002-00	0.01 µF		500 V
C865	283-0002-00	0.01 µF		500 V
D161	152-0061-00	Silicon	Tek Spec	
D469	152-0278-00	Zener	1N4372A	0.4 w, 3 V, ±5%
D803	152-0061-00	Silicon	Tek Spec	
D805	152-0170-00	Silicon	Tek Spec	
D806	152-0170-00	Silicon	Tek Spec	
D810	152-0185-00	Silicon	Replaceable by 1N4152	
D822	152-0218-00	Silicon		
D832	152-0218-00	Silicon		
D847	152-0288-00	Zener	.4M140Z5	0.4 w, 140 V, ±5%
D865	152-0287-00	Zener	1N986B	0.4 w, 110 V, ±5%
L133	114-0200-00	60-120 µH		
L134	114-0174-00	120-280 µH		
L135	114-0174-00	120-280 µH		
L138	114-0241-00	23-64 µH		
L139	108-0497-00	14 µH		
L233	114-0200-00	60-120 µH		
L234	114-0174-00	120-280 µH		
L235	114-0174-00	120-280 µH		
L238	114-0241-00	23-64 µH		
L274	108-0226-00	100 µH		

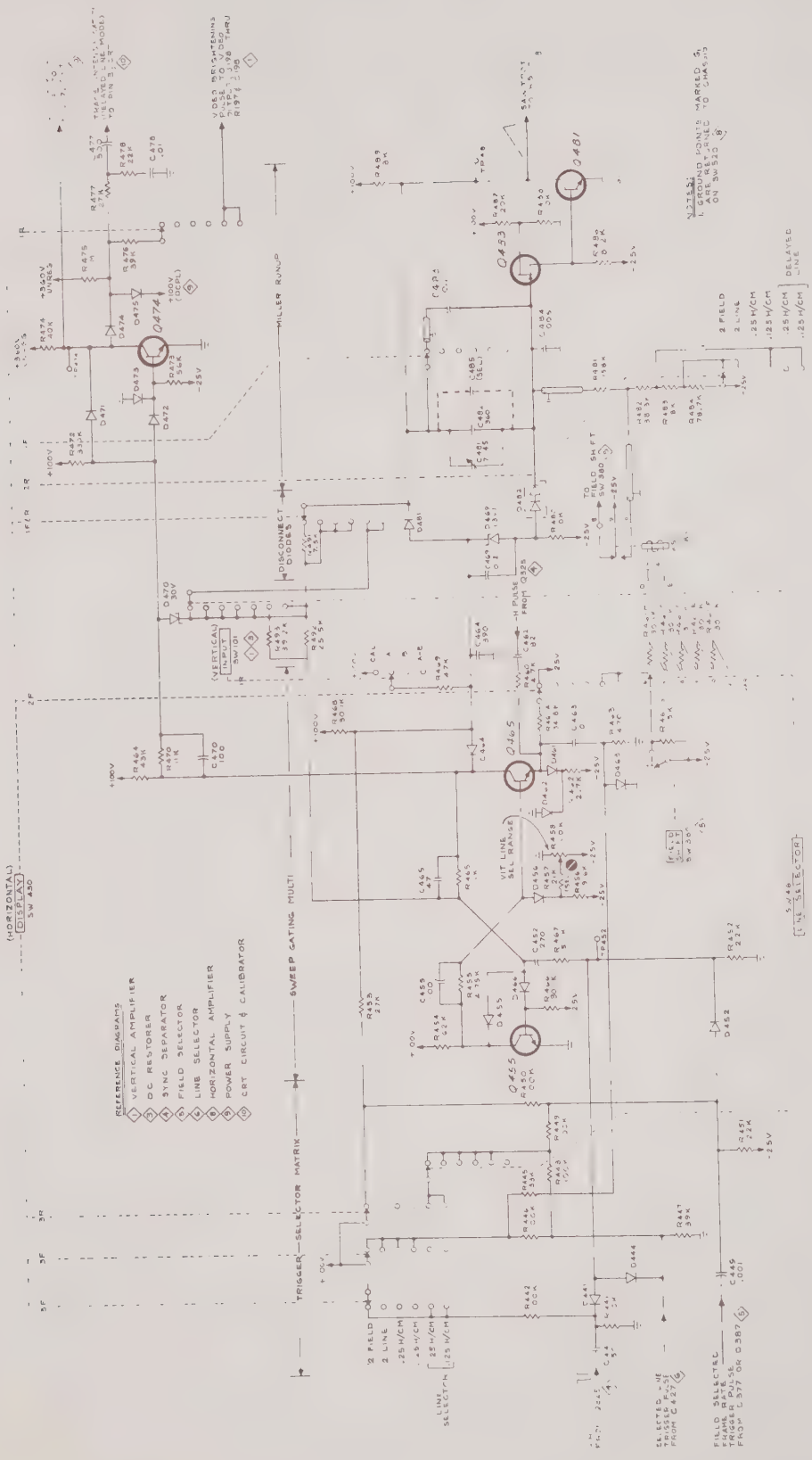
ADD: (cont)

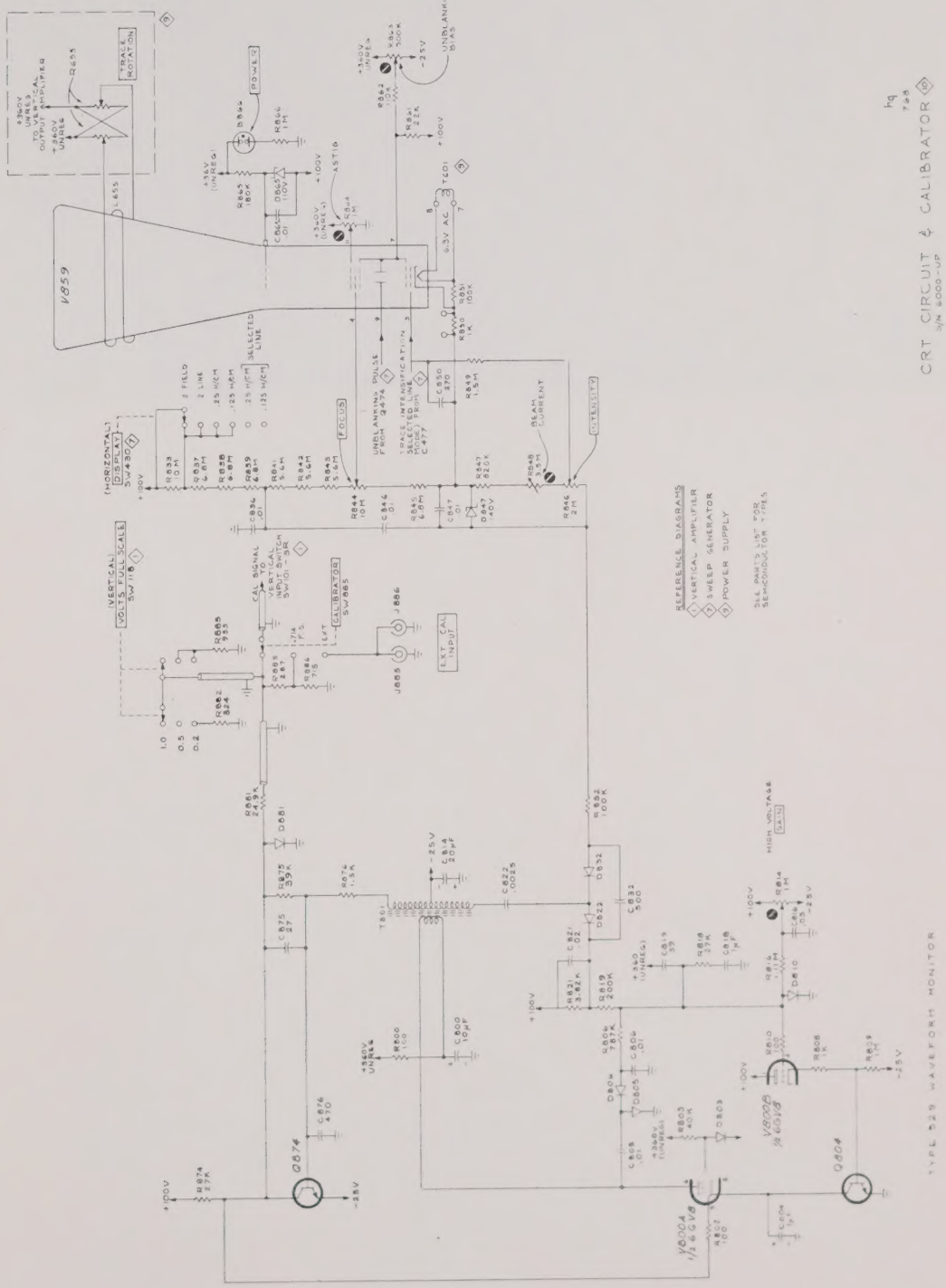
R125	321-0267-00	5.9 kΩ	1/8 W		1%
R138	315-0470-00	47 Ω	1/4 W		5%
R161	308-0241-00	22 kΩ	7 W	WW	1%
R165	316-0101-00	100 Ω	1/4 W		
R238	315-0470-00	47 Ω	1/4 W		5%
R265	316-0101-00	100 Ω	1/4 W		
R480	321-0289-00	10 kΩ	1/8 W	Prec	1%
R803	308-0168-01	40 kΩ	8 W	WW	1%
R806	323-0471-01	787 k Ω	1/2 W		1/2 %
R808	302-0102-00	1 kΩ	1/2 W		
R816	321-0145-00	1.11 MΩ	1/8 W	Prec	1%
R818	315-0273-00	27 kΩ	1/4 W		5%
R819	321-0414-00	200 kΩ	1/8 W	Prec	1%
R821	321-0249-00	3.83 kΩ	1/8 W	Prec	1%
R832	302-0104-00	100 kΩ	1/2 W		
R833	306-0106-00	10 MΩ	2 W		
R850	301-0102-00	1 kΩ	1/2 W		5%
R851	316-0104-00	100 kΩ	1/4 W		
R866	316-0105-00	1 MΩ	1/4 W		


V164
7
8
2
6,9
3
R163
C163
R165
100
+360 V
R161
22 K
D161
+100 V
PARTIAL
VERTICAL AMPLIFIER
1
R263
C263
3
V264
2
6,9
8
7
R265
100
+100 V
R121
R122
619
C122
TO
L139
2
R125
5.9 K
Q124
R123
C124
-25 V
-12.5 V
PARTIAL
DC RESTORER
3
Q274
C274
18
L274
100 μH
C275
56
R274
-25 V

SCHEMATIC CORRECTIONS




REFERENCE DIAGRAMS
1 VERTICAL AMPLIFIER
2 DC RESTORER
3 SYNC SEPARATOR
4 FIELD SELECTOR
5 LINE SELECTOR
6 HORIZONTAL AMPLIFIER
7 POWER SUPPLY
8 CRT CIRCUIT & CALIBRATOR
(HORIZONTAL) DISPLAY SW A30
TRIGGER SELECTOR MATRIX
SWEEP GATING MULTI
MILLER RUNUP
DISCONNECT DIODES
(VERTICAL) INPUT SW 101
CAL
VIT LINE SEL RANGE
TO FIELD SHIFT SW 380
HI PULSE FROM Q325
VIDEO BRIGHTENING PULSE TO CRT CATHODE R197 & 198
TRIG'D SWEEP (DELAYED LINE MODE) TO PIN 3 J1E
GROUND POINTS MARKED G ARE WIRED TO CHASSIS ON SW 522
2 FIELD
2 LINE
.25 M/CM
.125 M/CM
.25 M/CM
.125 M/CM
DELAYED LINE
SWEEP GENERATOR
S/N 6000-UP
SW 48
LINE SELECTOR
½ FIELD
2 LINE
.25 M/CM
.05 M/CM
LINE SELECTOR
.25 M/CM
.25 M/CM
SELECTED LINE TRIGGER FROM C427
FIELD SELECTED FRAME RATE TRIGGER FROM C377 ON Q387
529 WAVEFORM MONITOR


CRT CIRCUIT & CALIBRATOR
S/N 6000-UP
TYPE 529 WAVEFORM MONITOR
REFERENCE DIAGRAMS
1 VERTICAL AMPLIFIER
2 SWEEP GENERATOR
3 POWER SUPPLY
ALL PART'S LIST FOR SEMICONDUCTOR TYPES
V859
Q874
Q864
V8004
V8026
TRACE ROTATION
FOCUS
BEAM CURRENT
INTENSITY
UNBLANKING BIAS
CAL SIGNAL
EXT CAL INPUT
HIGH VOLTAGE
(HORIZONTAL) DISPLAY SW430
VERTICAL VOLTS/CM SCALE SW 115
CALIBRATOR SW885